Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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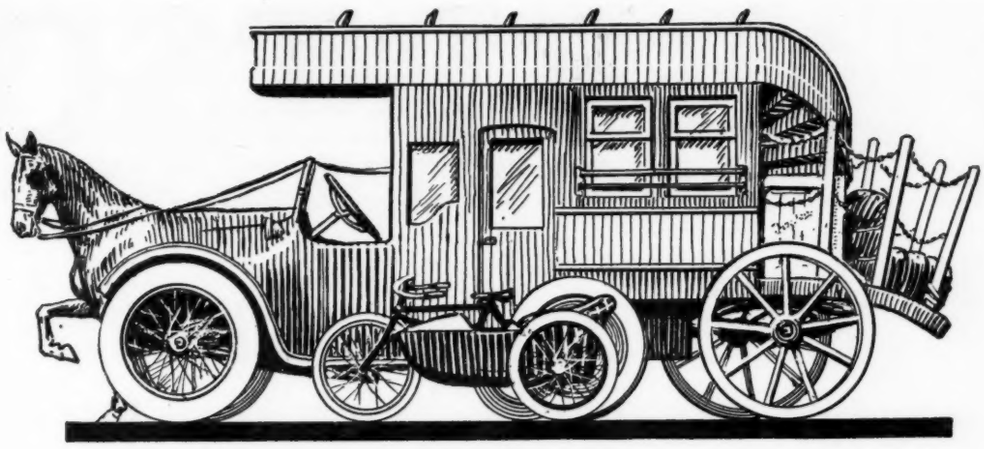

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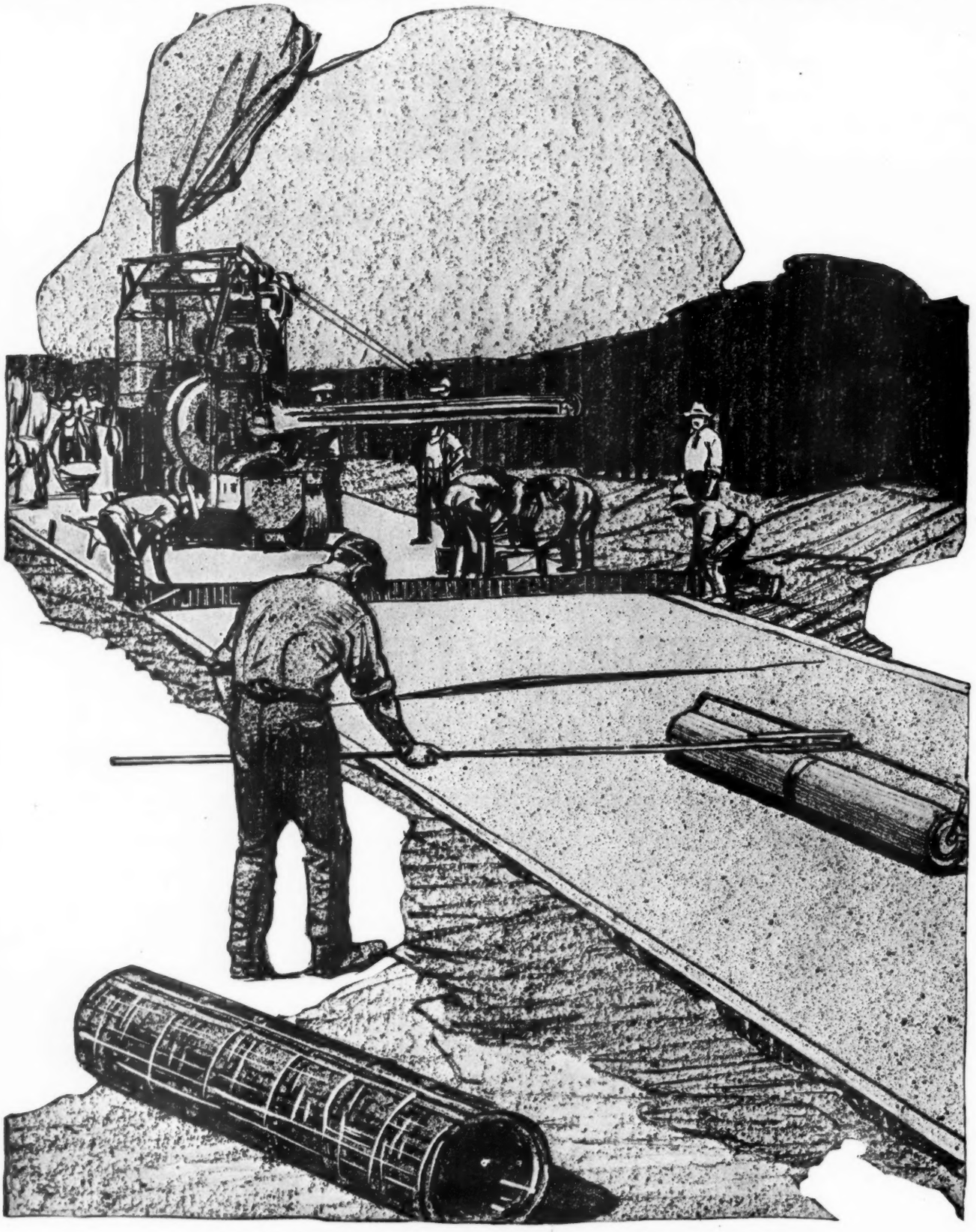

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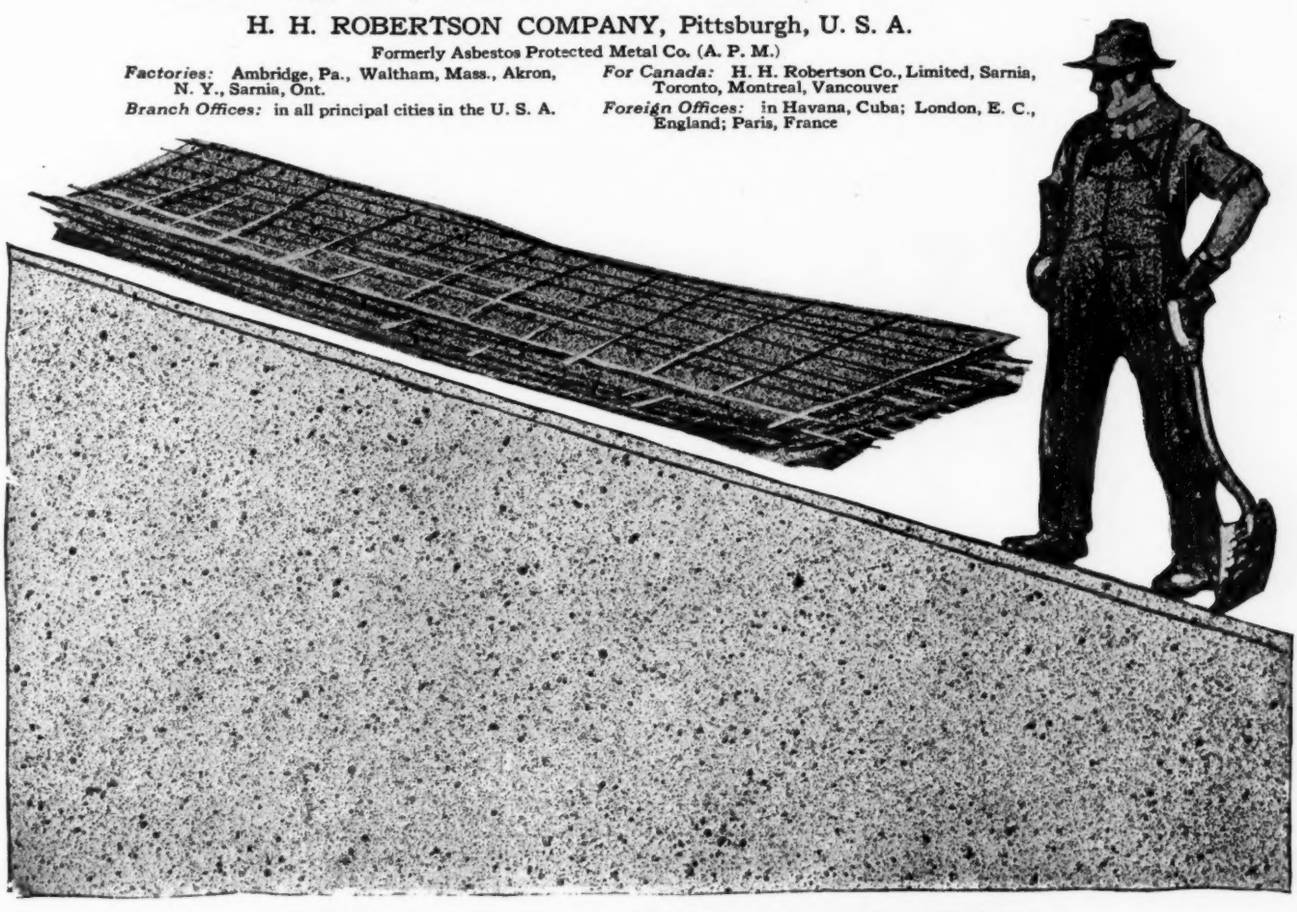

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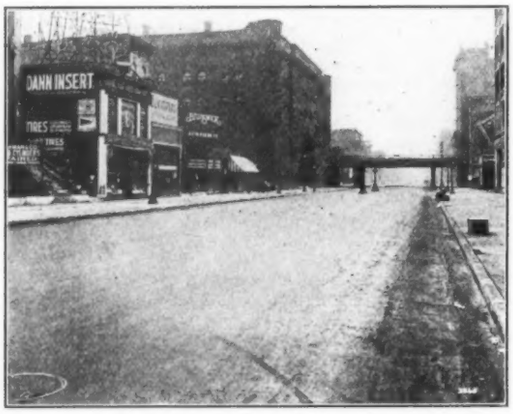

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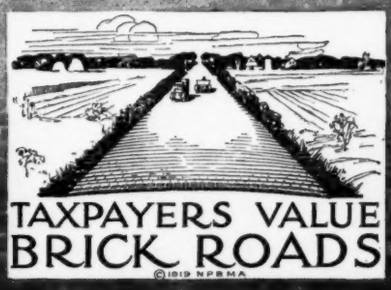

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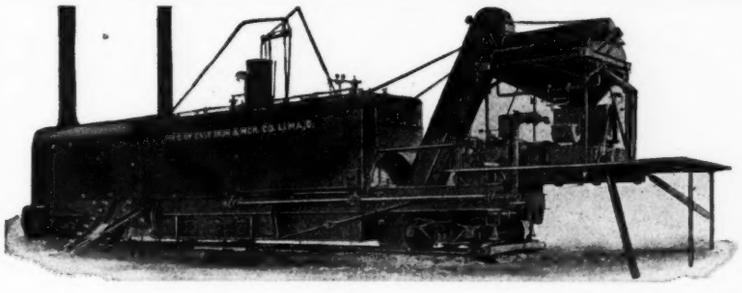

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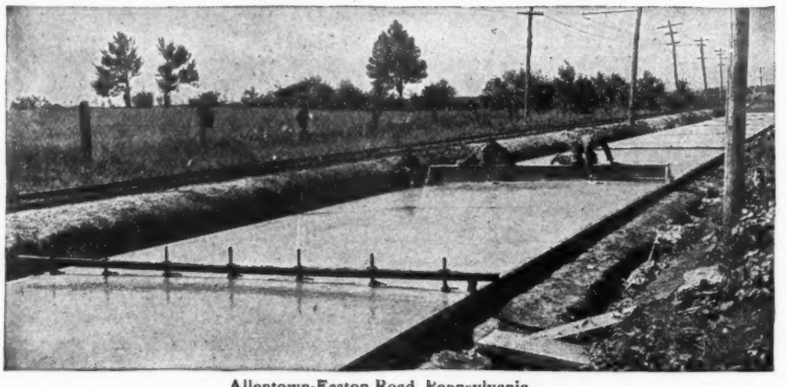

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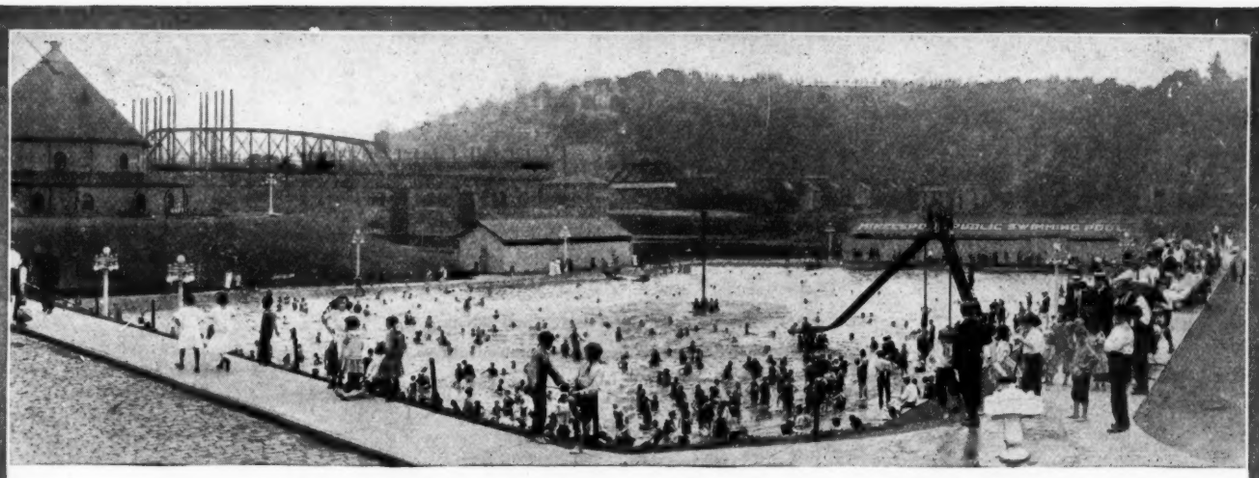

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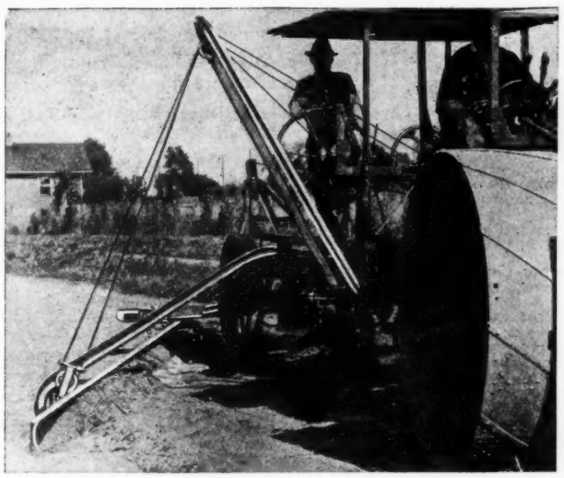

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Heaters (Rock and Sand).
Littleford Bros.

Heating Wagons (Oil and Tar).
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger

Hoists, Electric.
Pawling and Harnischfeger.

Hoists, Steam.
Lewis-Hall Iron Works.

Hot Mixers.
F. C. Austin Co., Inc.
Koehring Machine Co.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
H. H. Robertson Co.

Joint Fillers (Paving).
The Barrett Co.

Kettles (Portable).
Cummer & Son Co., The F. D.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Meter Boxes.
Ford Meter Box Co., The

Concrete Roads must be reinforced

It is demonstrated beyond doubt that to make concrete roads proof against heavy motor traffic, weather and time a fabric of steel must be incorporated in the concrete.

Several great States have so ruled.

American Steel and Wire Company's

Concrete Reinforcement

Fulfills every engineering requirement.

Send for our book on road building

CHICAGO
NEW YORK
CLEVELAND
PITTSBURGH
DENVER

BITOSLAG

Reg. U.S. Pat. Office

AN improved asphaltic concrete pavement composed of finely ground slag and especially prepared asphalt.

Bitoslag has demonstrated in practice that is is designed to meet all the demands of modern traffic.

Write for descriptive matter.

Bitoslag Paving Co.

90 West St., New York, N. Y.

Speed Up Gravel Production

Maximum development of the country's resources of natural road building material is essential to the rapid completion of the vast mileage of good roads for which hundreds of millions of dollars have been appropriated by the government and the various states.

The production of gravel to meet the huge demands of the road builders is, first of all, an excavating problem.

SAUERMAN DRAGLINE CABLEWAY EXCAVATORS

are machines of superior merit for excavating sand and gravel.

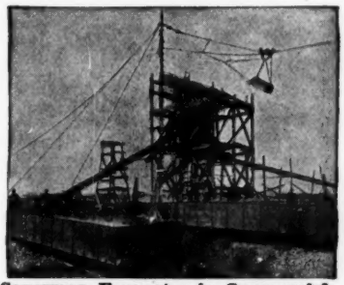
No other type of machine possesses the ability to cover an area of 500 ft. radius and dig, convey, elevate and dump material in one continuous operation without help of intermediate machinery.

No other type of excavator can excavate gravel from a stream or pool and convey to bins, hopper or cars. Sauerman Dragline Cableway Excavators are as efficient in digging under water as in a dry pit.

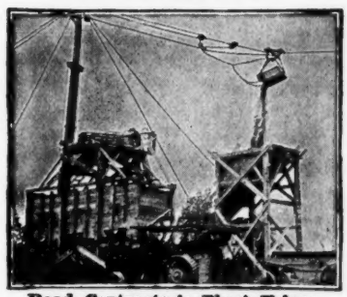
Sauerman outfits are economical to operate. One man at the levers of a two-drum hoist controls all the operations of digging, conveying, elevating and dumping. After dumping, the bucket returns to the digging point by gravity.

The experience of our engineers in installing our cableway excavators for hundreds of sand and gravel producers and contractors is at your service if you have a gravel deposit to develop or any similar excavating problem. Write us today.

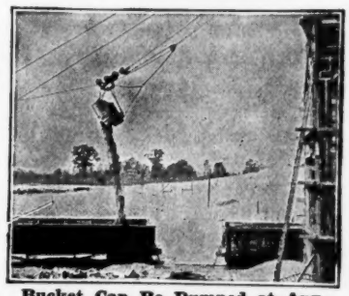
Sauerman Bros.
1142 Monadnock Block
Chicago
Mnfrs. of Cableway Excavators Power Scrapers and Cableway Accessories



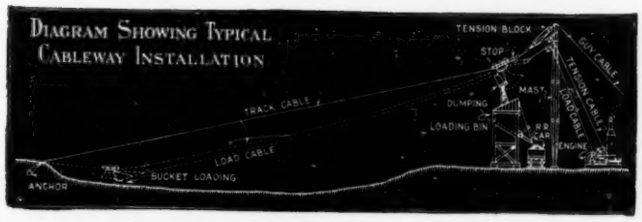
Sauerman Excavator in Commercial Sand and Gravel Plant



Road Contractor's Plant Using One of Our Machines



Bucket Can Be Dumped at Any Desired Point on Cableway



BUYERS' GUIDE

Mixers, Asphalt.
F. C. Austin Co., Inc.
Cummer & Sons Co., The F. D.
Koehring Machine Co.

Mixers, Concrete.
F. C. Austin Co., Inc.
Koehring Machine Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Pierce-Arrow Motor Car Co.
Service Motor Truck Co.
J. C. Wilson Co.

Motor Trucks.
Acme Motor Truck Co.
Autocar Co.
Federal Motor Truck Co.
Duplex Truck Co.
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Pierce-Arrow Motor Car Co.
G. A. Schacht Motor Truck Co.
Service Motor Truck Co.
J. C. Wilson Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Autocar Co.
F. C. Austin Co., Inc.
Federal Motor Truck Co.
Garford Motor Truck Co., The
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Pierce-Arrow Motor Car Co.
G. A. Schacht Motor Truck Co.
Service Motor Truck Co.
J. C. Wilson Co.

Municipal Castings.
Dee Co., Wm. E.
Ellwood Foundry
Madison Foundry

Paints (Asphalt).
Barrett Co., The
H. H. Robertson Co.
Truscon Steel Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
H. H. Robertson Co.
Truscon Steel Co.

Paving Joint Filler.
The Barrett Co.
H. H. Robertson Co.

Paving Machines.
F. C. Austin Co., Inc.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Koehring Machine Co.
Warren Bros. Co.

Paving Plants (Asphalt).
F. C. Austin Co., Inc.
Cummer & Son Co., The F. D.
East Iron & Machine Co.
Koehring Machine Co.
Warren Bros. Co.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
H. H. Robertson Co.
The Texas Co.

Pipe Manufacturers.
American Cast Iron Pipe Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
F. C. Austin Co., Inc.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Koehring Machine Co.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.

Powder.
DuPont, DeNemours & Co., E. I.

Pumps (Contractors).
Holzbog & Bro., Geo. H.

Reinforcing For Pavements.
American Steel and Wire Co.
H. H. Robertson Co.
Truscon Steel Co.

Road Building Material.
Barber Asphalt Paving Co.
H. H. Robertson Co.
The Texas Co.

Road Binder.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Baker Mfg. Co.

Road Machinery.
F. C. Austin Co., Inc.
Austin-Western Road Machinery Co., The
Baker Mfg. Co.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Koehring Machine Co.
Mayer, F.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co.

Road Oils and Preservatives.
The Barrett Co.
DuPont Chemical Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Barber Asphalt Paving Co.

Rock Crushers.
Austin-Western Road Machinery Co., The
Williams Patent Crusher & Pulverizer Co.

Rock and Sand Heaters.
East Iron & Machine Co., The

Roof Coating.
DuPont Chemical Co.

Roofing Material.
Barber Asphalt Paving Co.
The Barrett Co.
DuPont Chemical Co.
H. H. Robertson Co.
The Texas Co.
Warren Bros.

Sand Dryers.
Cummer & Son Co., The F. D.

Sandstone.
Cleveland Stone Co.
Ohio Quarries Co.

Sanitary Carts.
Holzbog & Bro., Geo. H.

Scarifiers.
Austin-Western Road Machinery Co., The

Scrapers, Drag Line.
Pawling and Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co.

Scrapers, Power.
Sauerman Bros.

Sewage Pumps.
Holzbog & Bro., Geo. H.

Sewage Treatment.
Direct Oxidation Process Corp.
Electrolytic Sanitation Co.
Wallace & Tiernan Co., Inc.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.

Sewer Castings.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.
McNutt, Lewis
Vitrified Pipe Mfrs. Assn.

Sewer Rods.
Stewart, W. H.

Sidewalks (Stone).
Cleveland Stone Co.
Ohio Quarries Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Co., Inc., F. C.

Sprinklers.
F. C. Austin Co., Inc.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co.
Williams Patent Crusher & Pulverizer Co.

Stone Curbing.
Cleveland Stone Co.
Ohio Quarries Co.

Stone Elevators.
Austin-Western Road Machinery Co.

Stone Flagging.
Cleveland Stone Co.
Ohio Quarries Co.

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co.

Street Cleaners' Carts.
Holzbog & Bro., Geo. H.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Crossings.
Cleveland Stone Co.
Ohio Quarries Co.

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co.

Street Paving Material.
Barber Asphalt Paving Co.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Co., Ltd., The

Structural Steel.
Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
F. C. Austin Co., Inc.
Austin-Western Road Machinery Co., The
Elgin Sales Corp.

Tamping Machines.
Pawling and Harnischfeger.

Tanks, Water Supply.
Mensch, L. J.

Tar and Pitch.
The Barrett Co.
DuPont Chemical Co.

Tar Heaters.
Alger Supply Co.
Littleford Bros.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith
Howard, J. W.
Kirschbraun, Lester
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co., The

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
F. C. Austin Co., Inc.

Trailers.
Warner Mfg. Co.

Trench Braces.
Kalamazoo Fdy. & Mach. Co.

Trench Machinery.
F. C. Austin Co., Inc.
Buckeye Traction Ditcher Co.
Holzbog & Bro., Geo. H.
Kalamazoo Fdy. & Machine Co.
Pawling and Harnischfeger

Valves.
Coldwell-Wilcox Co.

Wall Coping.
Cannelton Sewer Pipe Co.

Warrenite.
Warren Bros. Co.

Water Pipe.
American Cast Iron Pipe Co.
Cast Iron Pipe Publicity Bureau

Waterproofing.
Barber Asphalt Paving Co.
Barrett Co., The
H. H. Robertson Co.
The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Electric Ozone Sterilizer Co. of America.
Electrolytic Sanitation Co.
Pennsylvania Salt Mfg. Co.
Wallace & Tiernan Co., Inc.

Water Works Supplies and Equipment.
American Cast Iron Pipe Co.
Alger Supply Co.
Cast Iron Pipe Publicity Bureau
Coldwell-Wilcox Co.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Company

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Medal Paving Brick Co.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
Barrett Co., The
Republic Creosoting Co.

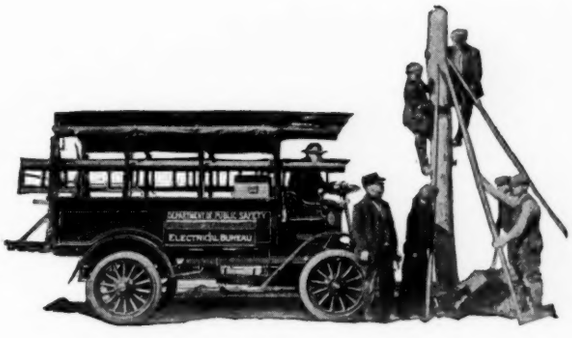
Wood Preservatives.
Barrett Co., The
DuPont Chemical Co.
Republic Creosoting Co.

MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation

Dependability and Constant Operation

In the rush of important municipal repairs, dependability of the transportation unit employed is essential.



Autocar short wheelbase assures speed and ease of maneuver in even the most congested districts. The inherent qualities to withstand the severe road and weather conditions anywhere, any time, provide an ideal unit for municipalities.

The Electrical Bureau of the Department of Public Safety, Philadelphia, experiences the satisfaction of constant operation.

CHASSIS (1½ TO 2 TONS)
$2300—97 inch wheelbase
$2400—120 inch wheelbase

THE AUTOCAR COMPANY
Ardmore, Pa. **Established 189?**
Factory branches and dealers in all principal cities

Autocar

Printed as insert to Municipal and County Engineering, Chicago, August, 1919.

MOTOR TRUCK OPERATION AND ACCOUNTING XLVIII

What Truck Users Think of Their Trucks

In compiling data for this section of MUNICIPAL AND COUNTY ENGINEERING, the editor is always pleased to note the great satisfaction felt by truck owners in the possession and use of their trucks. It is especially interesting to note that owners almost invariably feel that the truck they use is the best truck on the market. This is a wholesome condition and indicates that all good trucks are giving satisfaction in the municipal and county fields. One who has not had occasion to read many letters from truck users would be surprised to note the satisfaction with which these enthusiastic letters report that this or that truck, loaded, is such a wonderful puller that it not only pulls itself out of the mud, but at the same time pulls out one or more unloaded trucks of other makes. The veteran reader of such letters regards such enthusiasm as perfectly normal and proper and is pleased to regard it as an indication that users are happy and all is right in the truck world. Here are a few quotations from some letters from users in this field, recently received by the editor:

O. W. Spidel, City Forester, Milwaukee, Wis., writes: "The Diamond T truck in use in our department has proved very satisfactory. It has been in constant use since March, and so far has had no breakdown or any other trouble. We can recommend it for rough work, as our truck was used in the early part of the season on unpaved roads, in the outskirts of the city, and shows no signs of wear."

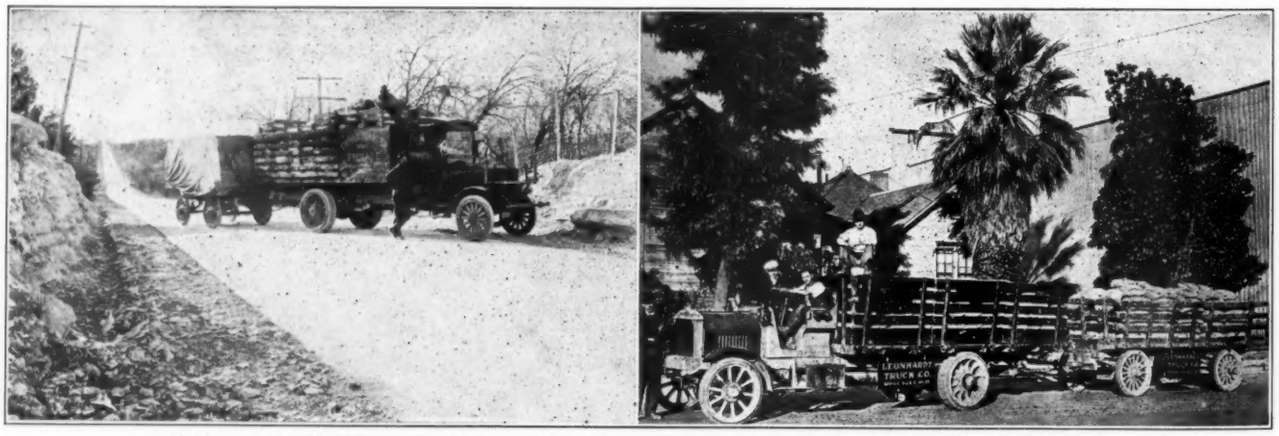
C. L. Gillatly, general superintendent, The T. J. Pardy Construction Co., Bridgeport, Conn., writes: "We have two other makes of truck which we are using along with one 3½ ton Atterbury truck. We have found from two years' experience that the Atterbury truck is capable of out-pulling any other truck which we have or any other truck which we have seen perform. In our business our trucks get in pretty tight places at times. We have never yet had an experience where the Atterbury truck could not pull itself out, in fact, it has pulled out other well known, standard trucks from a hole, when it was loaded and when the other trucks could not get out empty. The truck has given us very good service."

W. D. Riggs, manager of the Good Roads Machinery Co., Inc., Union Arcade Bldg., Pittsburgh, Pa., writes: "I am very glad indeed to write you regarding the Hall truck which we have been selling for the past four years. After looking over the many trucks, which we were offered, and after careful investigation of them we decided that the Hall truck was superior in many respects to any other truck on the market, especially for county and municipal road construction, not only in price of purchase, but in the low cost of maintenance. We are glad to advise that the Hall truck has lived up to all our expectations. We have sold five trucks to Kanawha county and two to Rowan county, West Virginia. In Pennsylvania we have sold two trucks to North Union township, two to Dunbar township, and two trucks to Logan township, Blair county. These have all been repeat orders and we have never had any complaint about any trucks we have sold. We believe, after our long experience with them, that the Hall truck is the best truck built for county or municipal highway work."

William M. Myers, director of the Department of Public Service, Richmond, Va., writes: "We have in our fire department six Mack trucks, of 2-ton capacity, with combination chemical engine and hose wagon equipment mounted on them. These machines have been in active and continuous service since 1915, and have rendered most satisfactory service, giving the minimum trouble, as motor apparatus troubles are considered, and I think it a high class machine and well suited for the rough service it is required to render in the fire service. We have had less trouble with the Mack than with any other motor apparatus we have."

Harry M. Bell, city engineer, Logansport, Indiana, writes: "Last year, in the early part of the summer, the city of Logansport purchased a 2½-ton truck of the Indiana Motor Truck Co. After using it for one year, almost day and night, winter and summer, we thought well enough of its performance that this summer we purchased another truck of the same make. Both trucks have given the city excellent satisfaction, with practically no expense for upkeep except tires and the general run of repairs incidental to using any truck."

Dan B. Butler, superintendent of street cleaning and maintenance, Omaha, Neb., writes: "We have two Master trucks in my department and they have given very good satisfaction. We have had these trucks for over two years and have used them constantly every day and have had very little expense for repairs."



MOTOR TRUCKS WITH TRAILERS ENGAGED IN INTERCITY HIGHWAY TRANSPORTATION.

Left: Acme 4-Ton Truck with Troy Trailer as operated by the Empire Transfer and Storage Co., Dallas, Texas, operates on Schedule between Dallas and Fort Worth, 35 Miles, carrying from 7 to 10 Tons of Freight, Faster and Cheaper than Rail Express. Right: Federal 3½-Ton Truck with Four-wheel Trailer as operated by the Leonhardt Truck Co., of Los Angeles, Calif., drawing 12 Tons to the load.

The Fourteen Points of Excellence of

Wilson *Dependable Motor Trucks*

ARE HERE STATED:

Wilson Trucks plowing their way through the mud and clay roads of Ohio and Pennsylvania, enroute to the Eastern Seaboard.

1 The WILSON truck is not a "mushroom" growth. Our organization has been engaged continuously in the manufacture of commercial vehicles in Detroit for the past thirty-six years.

2 And for nearly seven years of this period WILSON trucks have been built, sold and operated. Every WILSON ever built is still in successful operatoin.

3 Thus, a dealer selling WILSON trucks knows that the purchaser is securing his money's worth, and that the first sale means repeat orders. He has the very comfortable feeling, also, that an old and reputable Company is back of the truck.

4 Low maintenance cost of WILSON trucks makes WILSON owners the dealer's greatest asset in promoting sales.

5 Quality, efficiency and dependability considered, WILSON is the most inexpensive truck on the American market.

6 Comparison shows that all WILSON models are underrated as to carrying capacity. In other words, a large margin of safety is provided for the occasional unavoidable over-load. The WILSON tremendous hauling feat on Pike's Peak is still a record.

7 There are, it is true, other trucks in which you will find incorporated units similar to those in the dependable WILSON. But a very interesting fact in this connection is that such trucks are rated at a greater carrying capacity and sell for a higher price.

8 The reputation of WILSON motor trucks for dependable service and economy of operation is the result not only of their extreme simplicity of design, but of the remarkably fine workmanship and accuracy notable throughout all models.

9 The flexibility of WILSON construction and design has **absolutely eliminated** all chance of breaking parts or units due to inequalities of road surface.

10 Experienced operators invariably speak of the ability of the WILSON to get out of bad holes and the total absence of spring breakage in all WILSON models. This is largely due to the driving strain being transmitted through specially constructed rear springs—a feature of design adopted by the Government in its heavy military trucks.

11 And it is due to this sturdy ability and this lack of breakage in WILSON units and parts that many standard WILSON trucks are now owned and operated by the War Department of the United States Government, and are also largely in use in the Post Office Department throughout the country.

12 Gasoline economy is one of the many distinctive features of the dependable WILSON. This is due to its well designed motor, positive clutch, straight line drive, worm drive rear axle, flexible construction and perfect bearings, **and the proper engineering relationship of one unit to another.**

13 The J. C. WILSON COMPANY, although not the only manufacturer of high grade motor trucks, stands in a class by itself in building and selling trucks of the highest excellence of design, material and workmanship at noticeably reasonable prices.

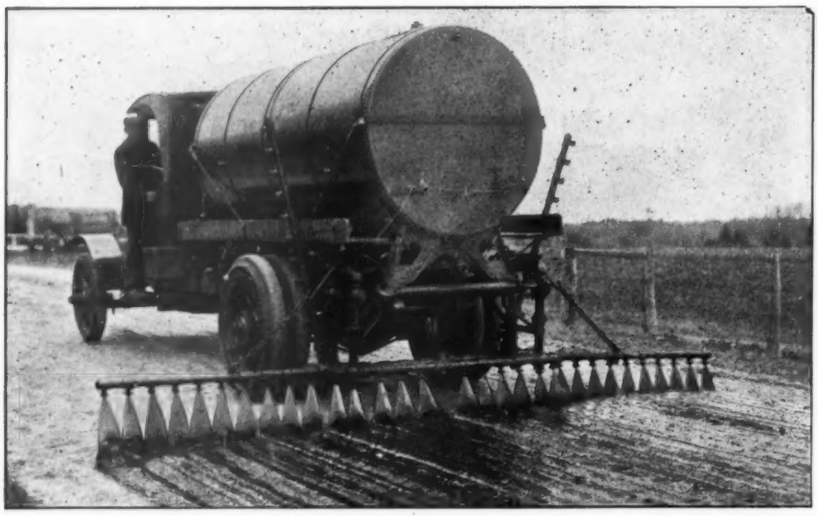
14 And the big distributors of the country are contracting for the dependable WILSON, not only because of this sterling value at reasonable prices, but also on account of the character and standing of the WILSON factory organization, and its honorable record as a manufacturing concern for the past thirty-six years. You will note with interest that WILSON distributors and dealers the world over are leaders in the business life of their respective communities.

J. C. WILSON COMPANY—36th Year

Export Office, 100 Broad St., New York. **DETROIT, U. S. A.**

LONDON – PARIS

1, 2, 3½ and 5 ton—All Worm Drive. ***A Model for Every Municipal and County need.***



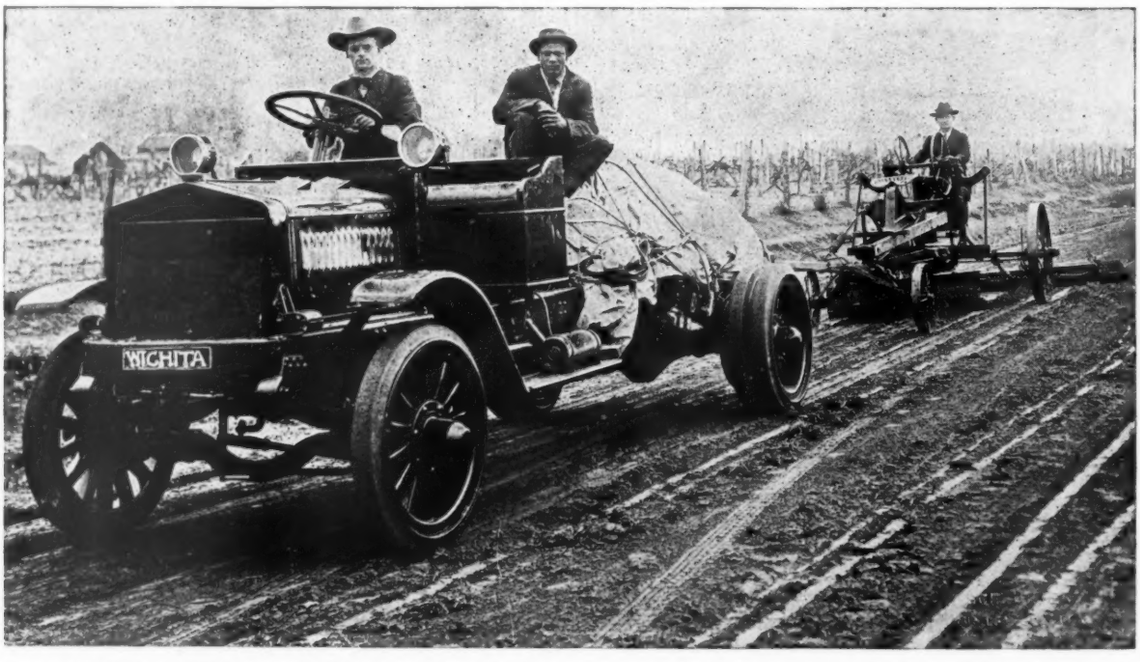
PIERCE-ARROW TRUCK EQUIPPED AS A ROAD OILER, SHOWING HOW DISTRIBUTOR PIPES CAN BE ADJUSTED TO VARIOUS WIDTHS OF ROADWAY.

Thomas Stone, chief of police, Chicago Heights, Ill., writes: "Our Little Giant truck was purchased in April, 1917, and has been in service every day since, and has given no trouble whatsoever. It is a combination patrol and ambulance. There is a great deal of ambulance work here, as there are many factories here, which give us plenty of ambulance work. Last fall, when the influenza epidemic was at its height, the truck was in constant use, day and night, and when the smallpox was raging there were 30 cases here. We made daily trips to Chicago with the truck and it proved very satisfactory. The truck in its daily runs gives on an average of 15 miles to a gallon of gasoline, and is very light on oil. After two years of service the truck was overhauled this spring, and all the bearings and connections were found to be in first-class condition."

Arthur W. Kreinheder, Commissioner of Public Works, Buffalo, N. Y., writes: "Our Atterbury truck has been in commission since May 11, 1918, hauling sand, crushed stone, brick, paving stone, etc., and has given very good satisfaction. The truck is of 3½ tons capacity and we figure it has done the work of three teams in an 8-hour day, effecting a saving of $4 a day, allowing $6 per day for a team."

Colin M. McLean, City Street Commissioner, Paterson, N. J., writes: "We have been using in this department a 6½-ton Mack truck for the following purposes: During the summer months the truck carries a 1,500-gal. tank for flushing purposes. In the fall of each year the tank is removed and a 10-yd. body is placed upon the truck and it is used during the winter months in the collection of garbage. Three months ago the flushing apparatus was changed and since that time we have been using the truck for oiling streets. The truck has been in operation for the past two years, and, outside of a few minor repairs, has given excellent service."

A. F. Moriarity, local manager, The Colorado Power Co., Leadville, Colo., writes: "We are very well satisfied with our Atterbury truck, and feel confident it has not only saved us considerable money, but at the same time we have been able to do more work with the same men than we would have done had we been using teams. Without going into accurate details, I would estimate that we have saved from $600 to $800 in a year's time by the use of the truck, beside the saving in time. Time is often an important element in considering the length of interruption to a power consumer; that is, with the truck the length of our interruptions is considerably decreased."



WICHITA 3½-TON TRUCK HANDLING GRADER IN ROAD MAINTENANCE WORK IN THE SERVICE OF WALKER COUNTY BOARD OF COMMISSIONERS, HUNTSVILLE, TEXAS.

For Road Building and Paving Work

few, if any, other trucks equal the splendid performance records of the *SERVICE 3½-ton Road Builders' Special.* It has greater strength in frame, springs and worm than is customary for trucks of its rated size. Twenty per cent super-strength in every part means long and satisfactory service.

Service MOTOR TRUCKS

are extremely powerful and rugged, and are designed to give long life under severe conditions. They are economical in operation and remarkably free from those weaknesses which make ordinary trucks fail under the strenuous grind of road building and paving work.

The officials of more than a score of American cities and as many counties can testify, thru experience, to the remarkable economy and efficiency of SERVICE Trucks.

Send for literature or consult your local SERVICE distributor

SERVICE MOTOR TRUCK CO.
WABASH, INDIANA, U. S. A.
Distributors in all Principal cities

NEW YORK
87-89 West End Ave.

CHICAGO
2617-25 So. Wabash Ave.

PIERCE-ARROW MOTOR STREET FLUSHER AS OPERATED BY THE CITY OF LOUISVILLE, KY., SHOWING FLUSHER NOZZLES AT REAR OF THE CAB.

F. W. Cappelen, City Engineer, Minneapolis, Minn., writes: "We have two Diamond T trucks of 3½ tons capacity and one of 2 tons capacity, and all three have given excellent satisfaction."

The Bridgeport Plumbing Supply Co., Inc., Bridgeport, Conn., writes: "We are very well satisfied with the Atterbury truck we have. It is in use every day and has been for two years previous to last April, our only expenses having been for the grinding of valves and removing the carbon. We have had no other actual repair on the truck and can highly recommend it."

Longevity of Motor Trucks

The life insurance expert can tell to a nicety how many men out of a thousand of a given age will be dead ten years hence, but so far there are no motor truck mortality tables.

Some trucks are ready for the scrap heap at the end of two or three seasons; others will last four, five or six years; still others seem to lead an endless life. One truck has covered upward of 241,000 miles in the past six years, with remarkably low upkeep cost, and it is still in daily use, apparently as dependable as ever. This truck was purchased June 5, 1913, and since that time has been in constant use by its owners, the Goldreich Fertilizer Co., of Marion, Ind. It is one of the early models produced by the Service Motor Truck Co., Wabash, Ind.

Another Service truck that shows remarkable longevity is one owned by Geo. Fricke, a painter of San Francisco. It has been in constant use for more than seven years and is still as serviceable as ever. The unusual feature of the latter truck is that the repair bill in 7 years has been only a little more than $60.

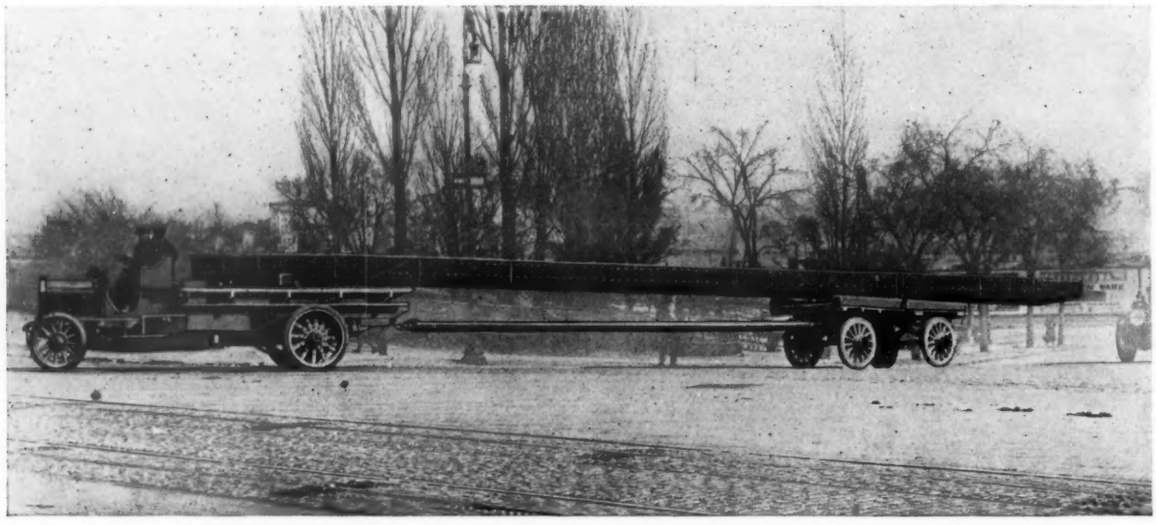
Real Economy in Mechanical Loading Devices

"The truck buyer should take pains to investigate the possibilities of saving money and time by speeding up his trucks and employes through the use of mechanical or electrical loading and unloading devices," says M. L. Pulcher, vice president and general manager of the Federal Motor Truck Co., of Detroit.

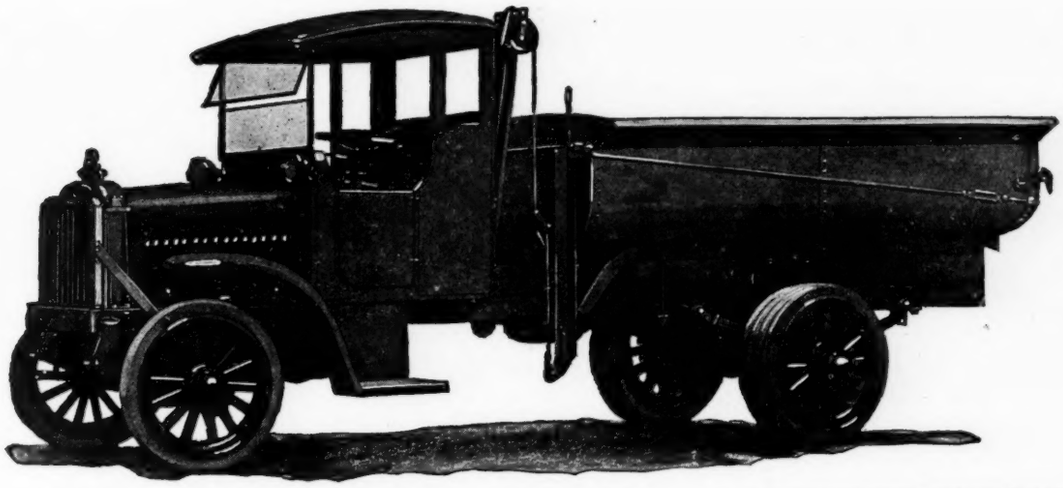
"Every truck user must have thought, at one time or another, of the economies in time and money which could be brought about by the use of mechanical or electrical loading and unloading appliances, which will either enable the driver of the truck to do all the loading with a minimum of effort and in the quickest time, or at least reduce the size of the shipping gang.

"Perhaps an owner has already figured out that, with more efficient methods or hauling devices at the loading or unloading stations, the truck could almost double up on the number of trips per day, depending, of course, on the distances and how unwieldy the packages really were.

"There are appliances which will save the truck owner labor time and truck time. One device I have in mind is the link-belt affair, which uses a small motor and is of especial util-



SAURER TRUCK AS OPERATED BY GEORGE H. PRIDE, NEW YORK, IN HAULING 65 FT. STEEL GIRDER WEIGHING 15 TONS UP 6 PER CENT. GRADE.



GRAMM PIONEER BERNSTEIN

A Truck Transmission Which Simply Defies Trouble

If there were no other reason for preferring Gramm-Bernstein trucks, B. A. Gramm's transmission alone would be reason enough.

Think of the expensive things which *can*, and *do* happen every day, to truck transmissions. Then note that *not one* of them can happen to ours.

Business men and truck owners blame transmission troubles for fully 60 per cent of usual truck layups.

Eighteen years of truck experience have shown us how to cure the one great and expensive transmission fault.

The Gramm-Bernstein transmission has been so designed that the gears are always in mesh.

They are never shifted—hence they cannot possibly be clashed or ground or chipped.

Speed changes are made by means of patented dog clutches—strong and tough and sturdy. These clutches enable easy shifting at any time and into any speed, going *fast* or *slow*, *up* or *down hill*.

This is especially valuable in hilly and mountainous sections. The driver can throw off his spark and use engine compression for braking purposes—thus saving much wear and expense on brakes.

The gears are mounted on extra large bearings. *They revolve on a heavy six-spline shaft.* They simply cannot get out of alignment.

So the Gramm-Bernstein transmission is driver-proof. It is protected absolutely—by its design, its construction, and its inter-locking speed shift, which prevents getting into two sets of gears at the same time.

It is proof also against every other common trouble. *In its entire assembly, for example, there is not a single pin, stud, set-screw, bolt or key which by any chance could work loose and fall out* with resulting serious damage to the entire gear set.

Replacements from every cause—carefully recorded over a 15-month period, in 1917-8, and covering all our trucks in use—averaged the negligible cost of 40 cents per truck.

So we say this transmission alone is reason enough for preferring Gramm-Bernstein trucks.

It is basic superiority. It goes to the very root of truck value and truck service. It is one of the factors contributing to the continuous hauling and the consequent economy which distinguish Gramm-Bernstein records.

Its tremendous advantages are exclusive to the worm-drive Gramm-Bernstein Pioneer line.

It is noteworthy that Mr. Gramm pioneered the truck industry 18 years ago, that Gramm-Bernstein eight years ago departed radically from then accepted transmission practice, and that this company now registers another departure by offering trucks completely equipped.

Gramm-Bernstein worm-drive trucks are made in 2, 2½, 3½ and 5-ton capacities—sold with complete equipment, at a flat price. Ready for the body—not an extra to buy.

The two-ton chassis, equipped, at $2700, is under the average of prices asked by 61 manufacturers for two-ton chassis without equipment.

Gramm-Bernstein Radiator showing radiator shutter open, radiator guard, pig-tail towing hooks and motometer.

All Gramm-Bernstein transmissions are provided with a pad for attaching Gramm's basic patent power take-off.

Dealers and truck owners should assure themselves that any trucks purchased with power take-off do not infringe B. A. Gramm's Basic Patent No. 1194994.

The Gramm-Bernstein Motor Truck Company, Lima, Ohio, U. S. A.

Pioneers since 1901—Builders of the First Liberty (U.S.A.) Truck

GRAMM PIONEER BERNSTEIN

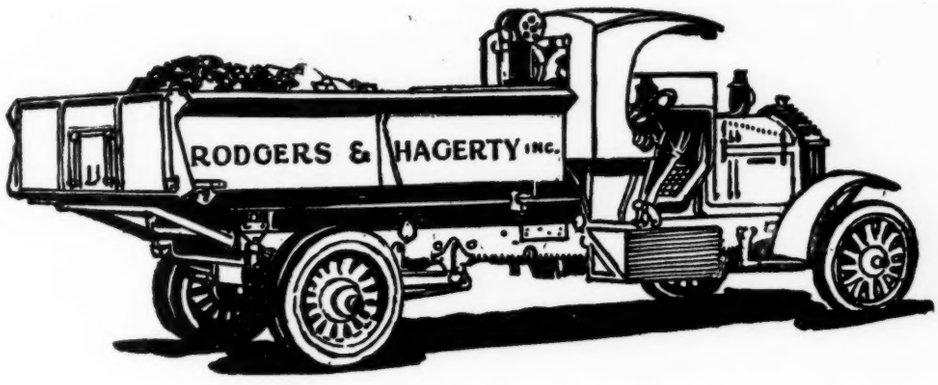
Why experiment? You can be sure

WHEN you can find out what Pierce-Arrow trucks have been doing in businesses like yours, under conditions similar to yours, with like problems to solve, it is foolish to experiment.

We make sure Pierce-Arrows make good by designing them to meet actual conditions, trying them out in every way and following them up day by day in the hands of owners.

We know what they have done for others, and we can tell you what they will do for you. Ask us.

RODGERS & HAGERTY, when building in South Brooklyn, the largest warehouse in the world for the United States Government, engaged fifteen hauling contractors. As many as 127 trucks worked on the job in a single day and 85 of them Pierce-Arrows. When speed and reliability were paramount, only Pierce-Arrows were employed as long as Pierce-Arrows could be obtained. Then other trucks were added.



Delivers more work in a given time;
Loses less time on the job and off the job;
Costs less to operate and less to maintain;
Lasts longer, depreciates less and commands a higher resale price at all times.

THE PIERCE-ARROW MOTOR CAR CO.
BUFFALO, N. Y.

Pierce Arrow

ity in coal yards. Pushed up against a coal pile and with a man shoveling coal toward it, it will feed its endless chain of coal containers into the pile and load the coal truck at a rapid rate—as low, I think, as 10 minutes for an 8-yd. truck."

Trucks and Trailers in Long-Haul Highway Transportation

Long-distance trucking between cities has developed into a thriving business in almost all sections of the country where roads are passable. Believing in making a truck pay by hauling big loads, the Leonhardt Truck Company, of Los Angeles, Calif., placed a 3½-ton Federal and a 4-wheel trailer into operation over 8 months ago under these conditions. Since then this truck has averaged 14 hours per day and—"I am loading 5 tons on my truck and 7 tons on the trailer and have plenty of reserve power for all different road conditions," declares J. I. Leonhardt.

He believes in as low a gear ratio as possible, so that the truck is able to start the heavy load with ease and to handle the load on stiff grades. Leonhardt uses distillate in the trucks, securing over 4 miles to the gallon and 208 miles to a gallon of oil, in spite of the heavy loads and steep grades over which the truck operates. He cites two of his hauls as examples of the service rendered by his truck: "Have been doing a great deal of hauling from Ventura, a distance of 70 miles, over the Santa Susana grade, which is 3 miles long and as high as 12 per cent. grade."

Another haul was from Camarillo. "When beans were shipped from Camarillo to Los Angeles by rail, it was necessary to handle the bags at least three times in getting them to the consignees' warehouse and four times if the warehouse was not on the railroad. This required three days, although Camarillo was but 50 miles distant. The truck goes into the field and pulls out with a load of 10 to 12 tons on truck and trailer. The load is transported direct to the warehouse and thus saves rehandling and delivers beans to the consignee, 50 miles from Camarillo, within 5 hours. To do this it is necessary to negotiate the famous Canejo grade, and the truck has taken this on second gear every trip, in spite of the tremendous loads."

This is another excellent example of the part motor trucks are playing by relieving the railroads of the unprofitable short-haul work, so necessary to get food products to the market.

Herewith is shown a picture of an Acme 4-ton truck and Troy trailer, owned by the Empire Transfer and Storage Company, of Dallas, Tex. The photograph was taken on Chalk Hill on the Dallas-Fort Worth pike. This equipment travels on a schedule between Dallas and Fort Worth, a distance of 35 miles, carrying from 7 to 10 tons of freight each trip between these points in less time than is required by rail express and at a considerably lower rate.

This truck has now been in service considerably more than six months running on a regular schedule and competing with railroad rates plus drayage. The Empire Transfer & Storage Company has all the business that can be handled with the present equipment, and this truck is operated continuously day and night. Two shifts of drivers and helpers are used regularly.

The service maintained by the Empire Transfer & Storage Company assures shippers in both Dallas and Fort Worth quick, daily transportation for the risk of breakage and the loss by theft is eliminated. Everything from chocolate drops to heavy machinery is handled and the regular load consists of approximately 12,000 lbs. of freight on the truck and about 6,000 lbs. of merchandise on the trailer.

The distance between Dallas and Fort Worth is 35 miles, 70 miles for the round trip, and it requires about 20 gals. of gasoline to pull a trailer with the load stated above.

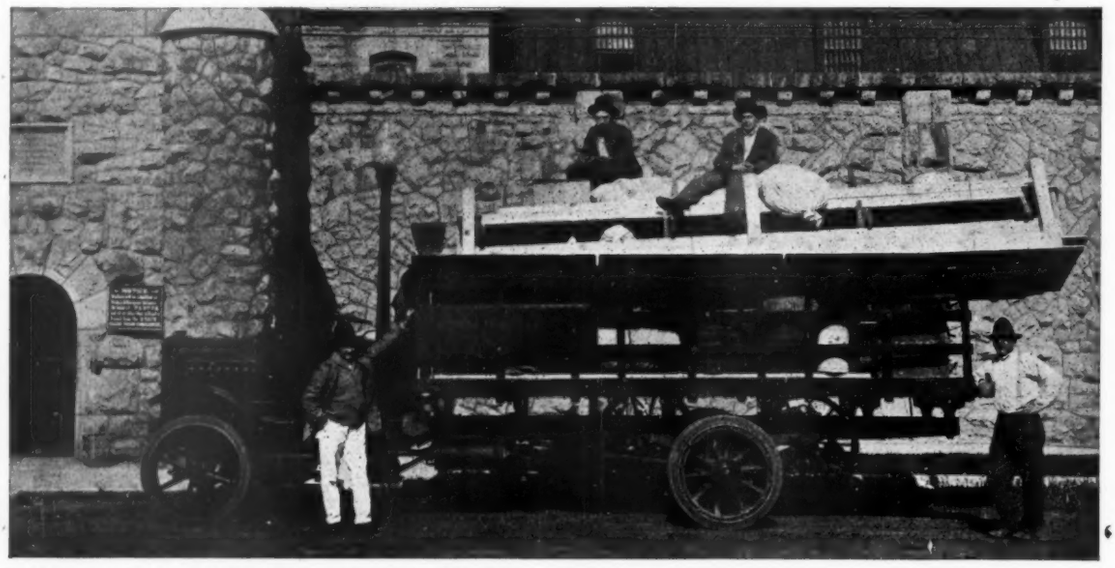
During the more than six months the truck has been in operation not more than $40 has been spent for spare parts and repairs and the truck is in excellent condition and good for a long time to come.

Five-Ton Truck Travels 50,000 Miles in Eleven Months in Intercity Haulage

In 11 months a 5-ton Pierce-Arrow truck owned by the New England Transportation Company accomplished more than the average truck does in three years. Because it had to work at an enormously high pressure to achieve this, its performance affords a striking example of Pierce-Arrow dependability.

The truck, used exclusively in long distance haulage between all New England points, traveled 50,000 miles from July 2, 1918, when it was put into operation, until May 1, 1919, when report was made on it. The total repair expense was less than $200, careful attention having been given to lubrication. This included the cost of new brake linings, valve-grinding and other normal adjustments.

During this period of intensive operation, the truck missed but four days all told. It operated usually seven days a week, and for many periods 24 hours a day, drivers working in two and three shifts. For six weeks the truck never was in a garage. For three weeks during the winter the radiator never got cool. Nearly 5,000 miles a month was covered in



RIKER 5-TON TRUCK AS OPERATED BY THE MONTANA STATE PRISON EQUIPPED WITH DOUBLE DUTY PLATFORM BODY FOR GENERAL HAULING AND WORK ON ROADS.

Another FEDERAL

"Shorten the miles to market—build better roads."

Combination Chemical and Hose Cart recently purchased by the Midland Fire Department, Patterson, N. J.

Federal-ized Fire Fighting in Patterson, N. J.

Guardians of human life and public property, municipal fire departments carry a burden of responsibility second to no other branch of civic government.

In the stern business of fire fighting, nothing but the most efficient and reliable of equipment can be tolerated.

For this reason, *good* motor trucks are replacing horse equipment universally.

And among the comparatively few makes of trucks so chosen, the growing number of Federals is significant of Federal dependability, speed, and ability to give year-round satisfaction.

FEDERAL MOTOR TRUCK COMPANY
35 FEDERAL STREET DETROIT, MICH.

FEDERAL

One to Five Ton Capacities

FLEET OF DENBY TRUCKS AS OPERATED BY THE PEOPLES EXPRESS CO., OF OAKLAND, CALIF., IN INTERCITY HAULAGE.

hauling miscellaneous freight from one point to another in New England.

Although rates considerably less than regular express schedule are charged, the truck's profits rapidly are wiping off the original cost of the vehicle.

Army Supply Base Built Quickly By Big Truck Fleet

Pierce-Arrow trucks which aided in the construction of the big army supply base at Port Newark, N. J., won an enviable reputation. The fleet employed on the task served as the backbone of the transportation system relied upon for the speedy erection of nine huge warehouses and two sheds. It was a notable engineering feat because an immense "fill" had to be made quickly.

The trucks faced unprecedented obstacles. Marshy, swampy ground had to be traversed. Roads did not exist. The muddy conditions presented an almost unsurmountable obstacle to truck operation.

Construction began in September, 1918. Four months later the nine warehouses and two sheds, each 1,150 ft. long by 160 ft. wide, had been completed. About 10,000 men were employed.

Indicative of the performance of the Pierce-Arrow fleet, may be cited the statement of W. J. Backfish, who had supervision of the entire transportation forces. He says:

"A fleet of about 200 trucks was employed to handle the 12,000 carloads of material used. Most of the well known makes of trucks were employed at first. Many of these makes soon were not represented at all, due to their failure to give continuous service; some were discharged and others were withdrawn by their owners because they could not find profit in maintaining them and operating them at our established rate.

"This was not true of the Pierce-Arrow trucks, of which about 150 were employed. In no case was a Pierce-Arrow truck discharged because of rendering inadequate service, and in only one instance was a Pierce-Arrow truck withdrawn by its owner."

How Concrete Roads and Motor Trucks Helped Solve Detroit's Milk Problem

The story of how 13,780 gals. of milk reach Detroit each day from the outlying communities of Elm, Plymouth, Stark and Perrinsville, is related interestingly by M. L. Pulcher, vice-president and general manager of the Federal Motor Truck Company of Detroit, Mich.

Six years ago, the story goes, the dairy farmers around Elm, Michigan, were called upon to arise at a particularly ungodly hour and, by superhuman efforts, they usually succeeded in getting their milk to the railroad station in time for the morning milk train. That is, they sometimes succeeded, but the time limit was so small that very often they failed to connect with the milk train.

Detroit Creamery Company officials objected strenuously to the railroad company and requested that the train schedule be set an hour or so later in order that the milk could be hauled to the station in time, and the railroad, in the obliging manner of its kind, promptly changed its schedule—only it made the time of the train one hour earlier instead of later, automatically bringing the rising hour of the Elm farmers to a time very closely approaching that at which many of their more fortunate city brothers were just going to bed.

And this was the opportunity which the Wilsons—father and son—grasped. They made a contract with the Detroit Creamery Company to haul all milk brought into Elm by farmers of that community. Later they also began operations out of Plymouth, Stark and Perrinsville.

Teams proved very slow for the hauls of 30, 18 and 19 miles, respectively, however, and finally the son persuaded his father to purchase a truck. Since that time their business has grown to a point where they are now using a fleet of 15 Federal trucks and haul from 12 different stations, of which Milan, 42 miles from Detroit, is the most distant point.

The difficulty of this haulage proposition lies in the variations in number of cans brought in by the farmers from day to day. For instance, a big Federal heavy duty tractor with semi-trailer, operates from Plymouth. The trailer will hold 204 cans—11.2 tons—and usually hauls a capacity load. Two days later, however, as like as not, the farmers will bring in from 225 to 250 cans which is more than can be loaded into the trailer. Accordingly, a four-wheel trailer must be loaded with the surplus, and picked up by one of the other trucks.

During the busiest season—May, June and early July—the number of cans brought in increases rapidly, too rapidly in fact to be properly handled outside of trucking distance from Detroit. Accordingly, the Detroit Creamery Company has established a condensory at Goodrich, which is operated only when surplus milk comes in. A Federal has been in operation here, hauling from Milford, for some time. This is a fifty-mile haul, and as a round trip must be made daily, two drivers are used.

The Detroit Creamery Company operates all stations—the Wilson's furnishing transportation to Detroit, operating on a basis of cans hauled. The average daily haul is 1,378 cans, or 13,780 gals. of milk. New stations will be started soon, in fact, stations will be opened at any place where farmers will bring in the milk.

Such a transportation system as this will tend to stabilize

Supplying Agricultural America With Uninterrupted Transportation

By George A. Kissel

Motorizing the Farm

Fresh from their triumphs in solving the transportation problems of Industrial America, the time has now arrived to tell how Kissel motor trucks **were successfully designed and built to help reduce the cost** of farm operations and solve the transportation of farm products.

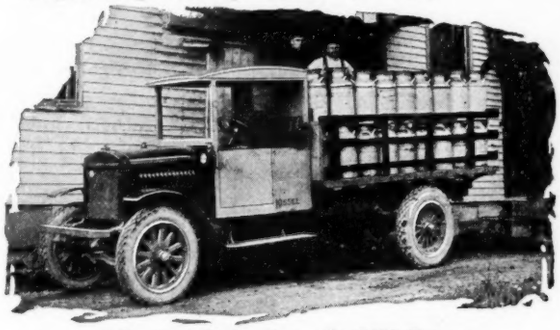
The Kissel engineers realized at the time when farm haulage methods were still "horse-limited," that "motorizing-the-farm" demanded special study of the farmers' requirements—the proper balance of fixed or moving units, weights, power and transmission requirements, strength of steels and materials.

It was this close application to the trucking essentials of farm work that enabled Kissel engineers to practically **design and build Kissel Trucks to fit farm requirements as if specially designed to meet them.**

For instance—they found that for a truck to be operated economically and efficiently, it must fit farm trucking conditions—i. e., right size to accommodate the farmer's body preference with full loading space and long wheel base, giving maximum capacity and perfect balance.

It must be built heavy and strong to stand up under capacity loads on country roads.

Take the Kissel-built power-plant, designed for Kissel Trucks exclusively—giving plenty of power for all grades—negotiating muddy roads or soft fields—climbing mountainous paths and corduroy roads, preventing overheating under severe conditions, with a high efficiency tubular radiator set in a cast-iron shroud; a powerful 18 inch fan drawn by a 2 inch belt and a centrifugal pump of the right size and design, insure an adequate cooling system.



"General Utility" on the Milk Route

And so it goes. The rear axles are of the type proven to be the best for country usage—strong, durable and easily accessible. Brakes are of super-strength to hold the load on all grades—springs are heavy and flexible, sturdy but pliant. The frames are designed for more strength than capacity calls for.

By equipping all four wheels with pneumatic tires, unusually satisfactory results were secured, negotiating sandy roads or freshly plowed fields without sinking or getting stuck in mud-holes.

Three Models for Farm Usage

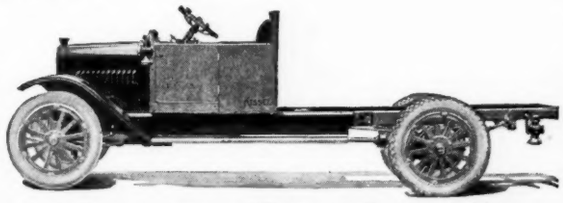
When these standardizing engineering practices and perfecting mechanical innovations were completed the proper combination of all parts and features was determined for each of the three following sized models, best adapted to farm work:

The "General Delivery" truck—¾ ton capacity—a reliable light delivery truck with ability to carry capacity loads at a good rate of speed, with an 8 foot loading space, unusually large tires, heavier transmission, new and decidedly heavier axles, improved seats. Ideal for quick trips to town—an emergency runner when produce must be shipped in a hurry.

The "General Utility"—1½ ton capacity. The farmer's choice for general hauling purposes, either on the farm or transporting produce and supplies between farm, city and shipping points—a good traveler—and is proving to be the "Farmer's Special" in getting his crops to shipping points or elevators.

The "Freighter" model, the masterpiece of the 2-ton field that comes nearer in performance and ability to the 2-ton U. S. Army "A" truck than any other truck on the market, with greater power than is usual in the average 2-ton truck.

The other two Kissel truck models are the "Heavy Duty" with a chassis capacity including body of 8,600 pounds, and the "Goliath" model with chassis capacity including body of 11,800 pounds.



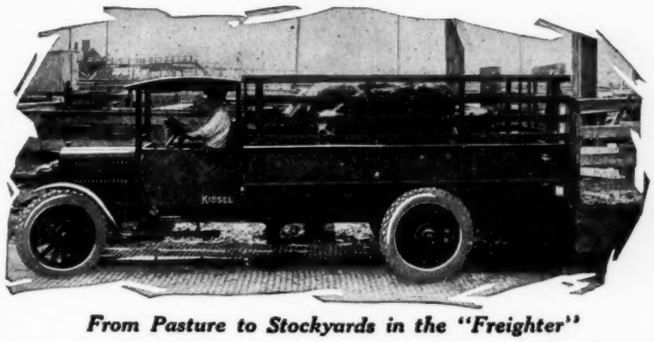
The ¾ ton "General Delivery" for Quick Trips

Some Unusual Performances

It is because the Kissel engineers have directed their attention to the haulage necessities of the farmers—that the records of Kissel Trucks on the farm stand out so prominently.

In Iowa the farmers haul their hogs and cattle to the Omaha stockyards in Kissel Trucks, saving transportation cost, time and shrinkage of stock.

Fruit growers in Florida and California drive their Kissel Trucks into the orchards where crated and boxed fruits are loaded for transportation to the railroad stations. In the truck garden centers—Kissel Trucks unload fresh garden produce in the nearby cities and return to the farms before the heat of the day sets in. Plying up and down over thousands of miles of rural motor express routes, Kissel Trucks bring in the produce of farms and fields and return home with luxuries and necessities.



From Pasture to Stockyards in the "Freighter"

On farms of all sizes, in all parts of the country, Kissel Trucks furnish power for the saw, separator, thresher, sileage cutter and other power-driven equipment.

In the Northwest, farmers are buying Kissel Trucks to haul beets, potatoes and wheat out of plowed fields, necessitating a truck of unusually great power.

Thus it can be seen that what Kissel Trucks have proven in the country's industrial life is well written in handling the transportation problems of farming communities.

Then there is the ALL-YEAR CAB, the biggest truck innovation for farmers in recent years, giving full protection from rain, snow, wind, etc., during winter use. Changed easily and quickly into an open summer cab by removing the winter attachments.

Your nearest Kissel dealer is prepared to show you how the perfection to which Kissel Trucks have been brought is your protection. Catalog on request, Kissel Motor Car Co., Hartford, Wis., U. S. A.

the quantity of milk received in any city and will tend to increase the quantity by providing a sure and ready market for all the milk the farmer can bring in.

Motor Truck Freight and Operating Costs

By R. E. Fulton, Vice-President International Motor Company

In handling freight by motor trucks two principles are involved: First, service; second, cost. Every question in connection with the use of motor trucks falls under one or the other of these heads.

Comparing railroad freight charges with motor truck freight charges it is necessary to include all the incidental items of expense connected with them.

Sometimes manufacturers figure that a railway freight rate of 50 cts. per 100 lbs. is cheaper than a motor truck freight rate of 75cts. per 100 lbs. between the same points. In the freight rate of 50 cts. all the expense of making the shipment, starting with the boxing or packing cost, and all other expenses incurred until delivery is made to the receiver in good order, have been overlooked.

The general traffic manager of one of the largest manufacturing concerns in the United States figured out what it cost them to ship freight by railroad and by motor truck between various eastern points. In railway freight cost he included the first class freight rate, by which their goods would have to be shipped, plus 15 cts. per 100 lbs., teaming charges from shipper's warehouse to freight house, plus 15 cts. per 100 lbs. teaming charge from freight warehouse to receiver's warehouse, plus 24 cts. per 100 lbs. increased cost of boxing to cover shipments on account of increased weight caused by increased boxing.

Without including several other items of expense, this gave the following table of comparative freight rates per 100 lbs.:

From	To	Via Freight	Via Motor Truck
Yonkers	New York	$1.04	$0.20
New York	Newark	.91	.15
New York	Passaic	.91	.18
New York	Paterson	.91	.20
New York	Elizabeth	.91	.20
New York	New Brunswick	.91	.40
New York	Trenton	.98	.60
New York	Philadelphia	1.02	.80
New York	Chester, Pa.	1.05	1.00
New York	Wilmington	1.13	1.20
New York	Coatesville	1.15	1.05
New York	Port Chester	1.02	.63
New York	Greenwich, Conn.	1.02	.63
New York	Stamford, Conn.	1.03	.65
New York	Norwalk, Conn.	1.06	.68
New York	Bridgeport	1.10	.70
New York	New Haven	1.13	.73
New York	Derby, Conn.	1.13	.73
New York	Ansonia, Conn.	1.13	.73
New York	Shelton, Conn.	1.13	.73
New York	Naugatuck, Conn.	1.15	.74
New York	Waterbury	1.16	.75
New York	Meriden, Conn.	1.16	.75
New York	Hartford, Conn.	1.21	.90
New York	Springfield, Mass.	1.25	1.00
New York	Holyoke, Mass.	1.25	1.10
New York	Worcester, Mass.	1.31	1.50
New York	Boston, Mass.	1.36	1.50
New York	Providence, R. I.	1.32	1.10

In addition to this, it is necessary in practically every case to prepare material for freight shipment in an entirely different way than when it is shipped by motor truck direct from shipper to receiver. There is a considerable additional expense for crating, or to protect by other means to prevent loss or damage in transit. This extra expense is necessary because of the number of handlings less than carload shipments receive at the hands of teamsters and carriers after the material leaves the shipping department. This increased protection and expense can be greatly reduced if shipments are made by motor truck, as the packages only need protection for loading at shipper's warehouse, in transit without transfer, and unloading at receiver's warehouse. Then in shipping by motor truck, instead of by rail, a great amount of clerical work in the form of extra bookkeeping, billing, etc., is eliminated. Where extra packing is necessary extra room is required for the boxing department. Then if railway freight shipments are delayed there is the additional trouble of tracing them. If the shipment arrives in damaged condition, there is the further difficulty of collecting from the railroad company.

Contrasted to this is the example of Marshall Field & Company, who guarantee to make delivery within 50 miles of their store within 24 hours, so well is their motor transportation system organized.

Boxing often carries from 10 per cent. to 20 per cent. of its weight in moisture, unless it is kiln dried prior to boxing. The Otis Elevator Company estimates that by the use of motor trucks it saves more than $100,000 a year in lumber alone.

Delivery time is all in favor of the motor truck and if manufacturers will take into account all the various costs and charges which are part of true freight transportation costs, they will find that motor trucks can be operated successfully and economically in competition with railways for distances between 10 and 125 miles.

In figuring the cost of operating trucks there are many faulty systems in use. These systems overlook many little items which find their way into the expense account and often cause considerable loss to the operator who overlooks them. The following table gives items of cost which must be determined upon the basis of size of truck, miles traveled and tonnage hauled:

- Assumption
  - Working days per year
  - Miles per day
  - Miles per year
  - Miles life of car
- Investment
  - Chassis with standard equipment
  - Body
- Fixed Charges
  - Interest on investment
  - Insurance
  - Fixed depreciation (exclusive of tires)
  - Wages
  - Garage rent
- Operating Charges
  - Maintenance
  - Tires
  - Gasoline
  - Oil and grease
- Total Cost per Annum
- Total Cost per Day
- Total Cost per Ton Mile

Often trucks will do unusual mileage at surprisingly small costs for repairs. We frequently get letters about Mack trucks that have given exceptional service. One of these unusual cases is that of the 2-ton Mack operated by M. Mauro, of Plainfield, N. J., which has traveled 45,000 miles with practically no expense for repairs. Another Mack has traveled 30,000 miles and the only repair expense incurred was $65 on account of the driver allowing the motor to freeze up last winter. Such remarkable service as this cannot always be expected; but these instances serve to show the possibilities of a good truck if given reasonable care.

Facts and Figures are Solicited

for publication in the ***Motor Truck Section*** of MUNICIPAL AND COUNTY ENGINEERING on the performance of motor trucks, with or without special equipment, in the public works field.

What character of service have trucks rendered in your organization? How has the cost of motor haulage compared with the cost of horse haulage, according to your observation? What are the factors controlling the limits of economical motor haulage, as you have observed them?

Readers are invited to submit for publication cost data on motor haulage in various kinds of public works activities. Actual cost data are requested; estimates of cost are not wanted.

Truck users will be compensated for submitting specific information of this character.

Municipal and County Engineering

538 S. Clark Street CHICAGO

HAUL IT IN A HALL

What Makes A Good Truck?

JUST what constitutes a good truck *Mechanically* and *Otherwise?*

There are, of course, a number of splendid, built-upon-honor trucks, representing magnificent value for anybody's money.

And HALL TRUCKS are in that particular class.

But, back of the best line of trucks ever made there should be something else—*something fully as valuable to you,* from an owner's viewpoint as built-in dependability and proven excellence.

Maker Responsibility—That's it.

Maker Responsibility guarantees continued factory service—not for one or two years, but for all the years to come.

Maker Responsibility means you'll not wake up some morning with "orphaned" trucks on your hands —white elephants forever after when it comes to replacement repair parts.

Maker Responsibility does not cease with delivery, but follows straight through to "in-service" road operation and owner satisfaction.

The makers of **Hall Trucks** *have been in business* **forty-six years.** *Is not that in itself complete, positive, indisputable evidence of* **maker responsibility?**

Hall Trucks *cover a complete line,* ranging from a 2-ton worm drive, to a giant 5–7-ton chain drive, all fitted with *any type body equipment desired.*

Give the *Hall dealer* in your territory a chance to demonstrate the true service value of **Hall Trucks,** or, write us direct for descriptive literature and complete specifications of all models. *Address Sales Department, No. 19, Roby Street, Detroit, Michigan.*

As Manufactured by
The LEWIS-HALL IRON WORKS
DETROIT, MICHIGAN

EDITORIALS

An Interesting Cost Plus Contract

A contract awarded on the cost plus variable fee basis, for constructing an earth fill dam and reservoir, which proved very satisfactory in securing bids and selecting a contractor, and which gives great promise of proving equally satisfactory on construction, is described in an article published in the water works section of this issue. The works will cost about $200,000.

It is of prime importance to note that twenty-three bids were received and that there was an unusual amount of interest shown by contractors in this job. Under the terms of this contract the engineer assumes more responsibility than is usually the case. Greater justice to both the contractor and the owner is secured than is provided by the old-style, lump-sum, gambling form of contract which has so long been in vogue. The engineers are of the opinion that this contract, which distributes the responsibility and risk and gives the contractor a square deal, will also, at the same time, effect a saving of about $10,000 to the owner.

It is very interesting to note with what experience and in what spirit the engineers approached the preparation of this contract. Early last year they had designed and supervised the construction of a bridge and a dam on the cost plus a fixed percentage fee basis. Later they were engaged on government work, on which construction was carried out under various cost plus contracts. They had much previous experience, also, with the weaknesses of the old set unit-piece contract, so they decided to draw up, for this dam and reservoir job, a contract on the cost plus variable fee basis, but in such a way as to permit free competitive bidding, to protect the owner against irresponsible contractors, while the owner assumed all normal risk in place of the contractor.

It is distinctly encouraging to all who wish to see the construction industry placed on a just and equitable basis to learn that the form of contract drafted has received commendation from many engineers as well as contractors.

The contract provides for payment for the actual cost of the work, plus a fee, with bonus and penalty clauses covering keeping under or exceeding the estimated cost, respectively. The engineer and contractor jointly keep account of the actual cost, properly itemized, and the contractor is paid this cost. The cost includes every expense immediately connected with the work, but excludes home office expense, interest on funds used, and all overhead except that in the field. Monthly payments are made the contractor of the actual cost incurred and approved, plus 3 percent on account of fee.

The contractor's bid and contract give unit estimated costs and a total estimated cost for the work, a percentage of the total estimated cost as fee for the construction, a time within which he agrees to complete the work, with a penalty as liquidated damages of $40 per day for exceeding the time limit, a complete statement of experience and qualifications, and a list of equipment to be used on the job, with total rental prices at which the plant is to be furnished for the entire construction.

Finally, the contractor's total fee is determined as follows: With the actual quantities of work completed and the estimated unit prices bid, a corrected estimated cost is made up. If the actual cost is then less than this corrected estimated cost, the contractor receives his bid percentage fee of the corrected estimated cost, plus one-quarter of the saving up to $10,000 and one-half of all saving above $10,000. If the actual cost is greater than the corrected estimated cost, the fee is reduced by one-quarter of the excess up to $10,000 and by one-half of all excess over $10,000, but in no case can the fee be less than 3 percent of the corrected estimated cost after deductions have been made of penalties for overtime and for excess cost.

The contract has much to commend it, especially its recognition of the fact, so long ignored, that a contractor is entitled to at least nominal compensation on every job he brings to a successful physical end. Incentive to great individual effort remains because of the bonus and penalty clauses. In general, under this form of contract, the contractor profits in proportion to the character of his performance, but he is protected against the losses so common under the old lump sum contracts.

Introducing the Engineer to the Public

The public has not yet acquired the habit of employing the engineer to solve engineering problems and to perform engineering services with the same precision and regularity with which it employs lawyers and doctors to handle hygienic and legal matters. While an important section of the public appreciates the engineer, another section, perhaps larger than the first, does not instinctively turn to the engineer for help when in need of the help he alone can give. What shall be done to correct this condition, which is at once a misfortune to the public and to the engineer? Doubtless many things might be done; something specific should be done.

We suggest that an organized publicity campaign be undertaken by some existing engineering society for the express purpose of telling the public of the work of the engineer and of his ability to serve. For the purpose of encouraging thought and discussion we shall offer some specific suggestions which do not necessarily represent our final thought in the matter, but which may serve to assist others in formulating a better plan.

First of all, let it be said that here is a case where Mahomet must go to the mountain. Though Mahomet has been very patient, the mountain gives no evidence of intention to go to him, so it is clearly his move, if any move is to be made.

The idea of engineering service must be "sold" to the public. The public must be convinced that the engineer can render helpful service not otherwise obtainable. This calls for publicity work.

Assuming that some national engineering society should become interested in directing this publicity work, what character of matter shall be selected for this purpose and how shall it be disseminated?

The newspaper reporter's enthusiasm over the engineering "feat" is well known. What is an engineering feat? The engineer would give one answer to this question and the layman another. What is commonplace to the engineer is an engineering feat to the layman. This seems to indicate, broadly, the character of matter that should be selected. There are not many great works of dramatic interest like the Panama canal, the Los Angeles and Catskill aqueducts, etc., and for this purpose that fact does not matter. Engineering enterprises that come closer to the average citizen are more desirable and exist in great variety. Let these be described in non-technical articles sent out broadcast to the lay press. In our opinion, such press releases would be widely used by lay publishers and would be read with real interest by the public. The articles should be prepared or edited by a publicity committee, properly organized for this purpose.

The public would also be interested to learn of the folly of intrusting the work of the engineer to the quack. Plenty of good, readable copy could be written on this subject.

The feature writer should not be overlooked. There are a number of men in the country who are uncommonly handy with the quill who make a business of writing feature articles for popular magazines of great circulation. Supply these feature writers with anecdote and application diagrams in the rough, and they will round out polished, clever and extremely interesting articles which publishers will buy and which the public will read.

In these and in similar ways publicity methods can be employed to acquaint the public with the nature of the engineer's work and his ability to render great service. The advantages of such acquaintance are as great as they are obvious.

News of Equipment Performance

A contributor to this issue says: "Progress in road-building methods seems to advance in sudden jumps rather than by means of slow development, and this applies as well to mechanical devices as to designs and types of construction." The contributor describes how improved mechanical means have been very successfully employed recently in speeding up the construction of monolithic brick roads and in improving the character of this important class of paved roadways.

The same statement holds good in general. Equipment is quite as important as design and the selection of material. For this reason news of equipment performances is just as important as news of improvements in design, in construction methods or in the selection and use of the materials of construction.

The editor has long appreciated the interest of the reader in articles telling of the performance of construction equipment. Many such articles have been published; many more are wanted for publication. To no other class of articles do readers respond so readily as to articles of this class. All readers are invited to submit data on the performance of equipment in the municipal and county fields for publication in this journal. Needless to say, flamboyant "puffs" are not wanted; merely straightforward statements of experience gained in the use of equipment are desired.

Highway Maintenance Costs

The leading article in this issue is of great interest to all highway officials, engineers and contractors, and to the entire highway industry. It describes the maintenance cost-keeping system employed by the Washington State Highway Department in keeping the cost of maintaining the primary highways of that State. The cost data covering the first two years of record are given and interpreted.

The value of such a cost record is great and the data are of high value when fairly and intelligently applied. Unfair conclusions might be based on a garbled account of Washington experience, but the article in question deals with fairness with all interests concerned. The explanatory matter shows that many items of cost are charged against maintenance in a fair but arbitrary manner. It is, therefore, well to point out that the tabulated data must be considered in the light of the context.

The author's conclusion covering the money value of hard-surfaced roads in reducing highway operating costs are especially interesting and deserving of attention.

The American Association of Engineers Is Getting Results

Unmistakable signs of interest in the work of the American Association of Engineers are being shown by the readers of this magazine. Our readers will be pleased to learn that the association is accomplishing tangible results in its labors to improve the compensation of salaried engineers. Two specific examples of success are here cited:

R. H. Aishton, Regional Director of the United States Railway Administration, for the Northwestern Region, has authorized salary increases in his region for those employed below the grades of chief draftsman and assistant engineer. This new schedule was made effective as of July 1, 1919, for those roads that had put into effect Supplement 7 to General Order 27. Authority was granted roads to put this Supplement into effect if they had not previously done so. This means that the engineers who did not get the increase of $25 per month, authorized under Supplement 7, will be given it. That order went into effect Sept. 1, 1918, and therefore entitles engineers who did not receive the benefit of it at that time to receive back pay of $25 for each month after and including September, 1918. This accomplishment, of such great value to railway engineers, is directly due to the efforts of the American Association of Engineers.

The association is also making progress in establishing better salary schedules for engineers in the public service. The St. Louis chapter of the association has obtained the support of the St. Louis Board of Aldermen in the campaign for higher compensation for engineers employed by the city. (The campaign was described in our June issue.) A bill introduced before the Board of Aldermen on May 16, 1919, had been approved by the Efficiency Board and indorsed by the Associated Engineering Societies of St. Louis, but was pigeon-holed by the Board of Estimate and Apportionment. In order to get action on the bill the St. Louis chapter of the American Association of Engineers drafted and had introduced before the Board of Aldermen a resolution requesting the Board of Estimate and Apportionment to call up the bill for consideration. As this resolution was adopted unanimously by the Board of Aldermen, and as Mayor Kiel had announced his support of the bill, it is expected it will be passed very soon. The bill provides for an increase of about 15 percent in the salaries of engineers, draftsmen and other technical men in the city's service.

Maintenance Costs of Primary Highways in Washington for Two-Year Period

By George F. Cotterill, Chief Engineer, Washington State Highway Commission, Olympia, Wash.

On June 7, 1917, the State of Washington inaugurated the plan of state-controlled, county-administered maintenance of its primary highway system. State funds, derived from the motor vehicle license revenue, are apportioned to the counties "for the sole purpose of maintenance and repairing primary and permanent highways or highways of like character, and for equipment for the maintenance thereof." The primary highways are required to be maintained by the counties "under such rules, regulations and requirements as may be prescribed by the State Highway Board." In case any county administration is delinquent or deficient in maintaining any section of primary highway up to the prescribed standards, the law authorizes direct maintenance by the State Highway Department at the expense of the county apportionment of funds until the delinquency is overcome.

A Total of 1,796 Miles Now Under Joint Maintenance

At the outset, 1,245 miles of constructed primary highways came under the operation of this system of state control of county administered maintenance. By June of 1918, the mileage had increased by completion of new construction to 1,410 miles, and at this writing (July, 1919), by completed construction and additional routes designated by the recent legislature as primary highways, a total of 1,796 miles is under the joint maintenance plan. This will continue to increase at the rate of 200 to 300 miles annually for the next three or four years until the entire 2,700 miles of designated primary highway system is completed with permanent construction.

From 50 to 75 Per Cent. of All Traffic is Carried by Primary Routes

Although this primary mileage comprises only about 5 per cent. of the established road system throughout the state (excluding streets within corporate limits of cities and towns), it is certain that at least 50 and perhaps as much as 75 per cent. of the entire volume of highway traffic is carried by these primary routes, upon which the through and local travel is concentrated. The principle of making the upkeep of these primary highways a prior claim upon the motor vehicle license revenue—whether administered by state or counties—is economically sound and has proved its adequacy in practice. Prior to 1919, the license schedule, graded generally on the basis of weights and horse-power, averaged about $7 per vehicle, and all the revenue (over cost of license administration, about 10 per cent. of collections) was apportioned to the counties for maintenance. The 1919 legislature, desiring to increase the construction fund, practically doubled the license schedule to an average of about $16 per vehicle. This assures about $2,000,000 revenue in 1919, and probably $2,250,000 for 1920. The first $1,000,000 annually (after license administration expense), is required to be apportioned to the counties and municipalities for the maintenance and upkeep of the primary highways within their limits as a prior obligation. After meeting this adequately, any surplus in the county apportionments is available for maintenance of the county permanent highways other than on primary routes.

Main Features of Cost-Keeping System

In the exercise of state control over county administration of primary highway maintenance, the State Highway Board, in June, 1917, prescribed in detail the methods and standards to be applied and required, including a uniform system of cost-keeping and monthly reports, thus compiling a continuing cost record of the maintenance and repair expenditures upon each section of highway. This cost-keeping system includes the following main features:

(a) The primary highways in each county are divided into consecutive sections in accordance with their respective types of construction and surfacing.

(b) The county or maintenance engineer in charge prepares each December an "Annual Cost Estimate" for each section of highway on a prescribed form providing for a distributed estimate against the following segregated cost items, viz: Patrol, Drainage, Dragging and Dressing, Clearing, Removing Obstructions, Resurfacing and Repair, Sprinkling, Sanding, Structures, Safeguards and Signs, Industrial Insurance, Equipment and Supplies, Supervision and Contingencies —the latter being 10 per cent. of the sum of all items preceding. These annual cost estimates are reviewed and modified as deemed necessary, by the County Board of Commissioners and finally are subject to approval of the State Highway Commissioners. The approved estimate for each section becomes its advisory budget for ensuing calendar year, and the total of all approved estimates in each county is set aside from the apportioned maintenance fund to meet the expenditures as they may be required.

(c) The engineer in charge prepares monthly reports of actual expenditures upon each section on a form segregated into cost items corresponding with the annual estimate, and extending in appropriate columns a simple system of budget bookkeeping for each item. The respective columns on each monthly report indicate "Expenditure, Month Reported"; "Previous Months, Calendar Year"; "Total to Date, Calendar Year"; "Budget Balance (or Deficit)." Each monthly report is prepared in duplicate, one for the county record, the other certified to the State Highway Commissioner. There is thus provided an expenditure report, cumulative each month, by which the responsible county and state authorities at all times have a permanent record of the physical and financial status of every section of primary state highway subject to their maintenance, administration and control.

(d) Special forms provide for detail explanation of annual estimates and monthly charges for "Equipment and Supplies" and for "Supervision," making a record of the apportionment of these general items as between the respective sections of highway upon which they are applied.

Explanation of Cost-Keeping Forms, Definition of Items, Etc.

The following matter, quoted from Bulletin No. 10 of the Washington State Highway Department, is here introduced to explain the cost-keeping forms, reproduced in the accompanying cuts, to define the items listed on the forms, etc.:

"A separate form shall be used for estimating and reporting the maintenance of 'each continuous, constructed section of primary state highway within the county.'

"For the purpose of estimates and reports the engineer shall divide each primary state highway into appropriate sections making the breaks between sections where the type of surfacing changes, so that each section reported shall be of the same general type of construction and surfacing. (Breaks need not be made by reason of planking, bridges or short sections of special surfacing interspersed in an otherwise continuous stretch of a prevailing type of construction.) For convenience in reporting the engineer may divide a continuous mileage of the same construction type into two or more sections, such divisions usually conforming to previous construction contracts.

"In designating highway sections, engineers will give consecutive numbers generally applying from the southerly county boundary northward, and from the westerly county boundary eastward. The mileage of each section shall be accurately checked and recorded to two decimal places (miles and hundredths).

"The dates and costs of construction are desired to be correctly entered in the heading of each section. It is realized, however, that engineers will have difficulty in some cases to give exact answers. Approximate estimates will serve until accurate information is supplied. In no event should any estimate be delayed for lack of this information.

Definition of Items

"The terms used in the forms for 'Annual Cost Estimates' and 'Monthly Report of Expenditures' are hereby listed and defined to include all labor, materials and other costs and expenditures applied in highway maintenance in accordance with the rules, regulations and requirements prescribed by the State Highway Board and segregated under the following headings for cost-keeping, estimates and reports, viz.:

Form 1

State of Washington ..... County

MAINTENANCE OF PRIMARY STATE HIGHWAYS

Annual Cost Estimate For the Calendar Year 19....

(Prepared in accordance with Rules, Regulations and Requirements of State Highway Board prescribed under State Law.)

To the Board of County Commissioners of ..... County, Washington.

I do hereby certify the respective amounts set forth in the second column of the form below, and their total, as an itemized and complete estimate of the cost of adequate and proper maintenance of that certain continuous, constructed section of primary state highway described in the title of said form, throughout the annual period beginning January 1, 19....

Witness my hand this ..... day of ....., 19....

..... (County (or Maintenance) Engineer.

..... Highway; Section No. ..... ; Length ..... Miles

Beginning at .....

Ending at .....

Graded, 19.....; Roadbed width { Cuts ..... ft. / Fills ..... ft. }; Cost { Grading and structures (except Bridges 20' or more span) $ ..... / Bridges, 20' or more span, total length ..... ft. $ ..... }

Surfaced or Paved, 19.....; Width ..... ft.; Type ..... ; Base ..... ; Thickness { Crown ..... / Sides ..... } Cost $ .....

ITEMIZED MAINTENANCE ESTIMATE FOR ANNUAL PERIOD.

SEGREGATED COST ITEMS (For definitions see Bulletin No. 19)	Expenditures Preceding Year	Estimate for Ensuing Year	As Modified by Co. Com'rs	As Modified by St. H'w'y Com'r	REMARKS
(A) Patrol	$	$	$	$	
(B) Drainage					
(C) Dragging and Dressing					
(D) Clearing					
(E) Removing Obstructions					
(F) Resurfacing and Repair					
(G) Sprinkling (or Sanding)					
(H) Structures					
(I) Safeguards, Signs, etc.					
(J)					
(K)					
(L) Industrial Insurance					
(M) Equipment and Supplies					
(N) Supervision					
(O) Contingencies					
Total of Estimate	$	$	$	$	

(*N. B. If no modification ordered, cancel bracketed words.)

To the *State Highway Commissioner and Board.*

The Board of County Commissioners of ..... County, Washington, having duly considered the Engineer's Annual Estimate, providing for maintenance of the above described section of primary state highway for the ensuing annual period, all as set forth in the form above (*and having ordered certain modifications thereof and entered same in the third column), does hereby approve and adopt said Estimate (*with such modifications), as the Advisory Budget for the maintenance of said section of highway; and the Board does hereby declare the total of said (*modified) Estimate to be the amount necessary to provide adequate and proper maintenance in accordance with the methods and standards prescribed by the State Highway Board for the said section of highway, throughout the annual period included in the calendar year of 19....; and the Board does hereby set aside and make available for said maintenance as required; the total amount of said Estimate, together with the totals of similar approved annual estimates covering the maintenance of other sections of constructed primary state highway within the County, declaring same a prior claim upon the County Permanent Highway Maintenance Fund available during said annual period, and upon the permanent highway fund to the credit of said County if the maintenance fund be insufficient, and further agreeing, in event both said funds are unavailable or insufficient, to provide any remainder from the general road and bridge fund; costs provided by Section 5, Chapter 115, Laws of 1917.

Approved and adopted this ..... day of ....., 19....

Attested and certified to State Highway Board the day and date above named.

Board of Commissioners of ..... County.

..... County Auditor and Clerk of Board.

FORM 1 OF THE WASHINGTON HIGHWAY MAINTENANCE COST KEEPING SYSTEM FOR ANNUAL COST ESTIMATE.

Form 2

State of Washington ..... County

MAINTENANCE OF PRIMARY STATE HIGHWAYS

Monthly Report of Expenditures ..... (Insert month) 19....

(Prepared in accordance with Rules, Regulations and Requirements of State Highway Board prescribed under State Law.)

To the Board of County Commissioners of ..... County, Washington, and to the State Highway Commissioner.

I do hereby certify the respective amounts set forth in the first column of the form below, as being a true and correct segregated cost statement of expenditures made and property apportioned upon that certain continuous, constructed section of primary state highway described in the title of said form, for the maintenance thereof, during the month of ....., 19....

Witness my hand this ..... day of ....., 19....

..... County (or Maintenance) Engineer.

..... Highway; Section No. ..... ; Length ..... Miles

Beginning at .....

Ending at .....

ITEMIZED MAINTENANCE EXPENDITURES, ... (Insert month) 19....

SEGREGATED COST ITEMS (For definitions see Bulletin No. 19)	Expenditures Month Reported	Previous Months Calendar Year	Total to Date Calendar Year	Budget Balance (*Deficit)	REMARKS
(A) Patrol	$	$	$	$	
(B) Drainage					
(C) Dragging and Dressing					
(D) Clearing					
(E) Removing Obstructions					
(F) Resurfacing and Repair					
(G) Sprinkling (or Sanding)					
(H) Structures					
(I) Safeguards, Signs, etc.					
(J)					
(K)					
(L) Industrial Insurance					
(M) Equipment and Supplies					
(N) Supervision					
(O) Contingencies (see below)	Entry	Opposite	Each Item	Item	
Total					

Distribute Expenditures for "Contingencies" to the appropriate items as per definitions. Describe in space below the location, character and cost of any work or expense classed as a "contingency."

Make general statement of maintenance conditions of this section of highway, noting any plans or suggestions for improvement.

Certified as a true copy of report filed with County Commissioners the ..... *day of* ..... 19....

..... County Auditor and Clerk of Board.

FORM 2 OF THE WASHINGTON HIGHWAY MAINTENANCE COST KEEPING SYSTEM FOR MONTHLY REPORT OF EXPENDITURES.

"(A) Patrol: The prescribed maintenance patrol, including systematic inspection of the entire road section, immediate attention to drainage defects, removal of slight obstructions and such general 'first aid' repair service as can most effectively be rendered by a road patrol, as distinguished from definite, stationed work capable of more direct cost segregation under other item headings.

"(B) Drainage: The observation, care, upkeep, repair, renewal, replacement, enlargement, extension, diversion or other required modification of ditches, drains, inlets, culverts, channels, outlets and other drainage facilities which have been provided in constructing the highway or which may become necessary for the stability and permanence of the roadbed and the usefulness for traffic purposes of the surfacing thereof at all seasons (snow blockades excepted).

"(C) Dragging and Dressing: The dragging, grading, dressing, rolling and ordinary upkeep of the various types of improved earth, gravel or crushed rock roads so as to make and keep a smooth, compacted surface for the highway at proper crown and grade; also similar service to shoulders and slopes, in cuts and fills, as necessary to maintain the roadbed and roadway with widths at least equal to and gradients as easy as the original construction.

"This heading shall be applied to sections of highway with 'hard surface pavement,' only as to maintenance of shoulders and slopes, and keeping the pavement clean.

"(D) Clearing: The removal and disposal of weeds, brush, trees, stumps, fallen timber and debris within the right-of-way, or when threatening the road or obscuring safe traffic vision at curves, even though outside the right-of-way.

"(E) Removing Obstructions: The removal of rocks and sliding material, including any trees, stumps, logs or debris therewith, which have encroached upon or threaten the roadway, ditches or other portion of the constructed highway; the widening of any cuts or removal of spoil banks which become obstructive of traffic or vision. The cost of providing and maintaining detours for traffic around obstructions shall be included with this item. Snow removal shall be estimated and reported under this head but special note of the amount thereof shall be made in the 'Remarks' column when annually estimated and when reported for the month of expenditure.

"(F) Resurfacing and Repair: The resurfacing and re-

newal to thickness and width at least equal to construction plan, of the various forms of gravel, crushed rock and macadam roadway.

"Applied to 'hard surface pavements' this item shall include all care, upkeep, repair and resurfacing, including such partial renewals of pavement as may be made under the limitations of maintenance prescribed by the State Highway Board. Any pavement renewal to full width of roadway and exceeding 30 ft. in length shall be specially noted in 'Remarks' column, with location, length and cost thereof.

"(G) Sprinkling (or Sanding): The treatment of any section of highway by sprinkling same, for the convenience of traffic by dust prevention and for the preservation of the highway surface material.

"This heading shall be applied to 'hard surface pavements' when treated by 'sanding' or other topping treatment required for traffic needs or safety, especially in overcoming slippery conditions.

"(H) Structures: All work on any bridge, trestle, cribbing, retaining wall or other highway supporting structure (except drainage structures) or on any form of planked roadway, including safety inspection, care, upkeep, repair, strengthening, attention to walks, railings and safeguards, planking, paving, painting, renewals, reconstructions and replacements.

"Any estimate or report of expenditure proposed or made upon any structure for other than ordinary upkeep and repair, involving a substantial renewal, reconstruction or replacement shall be specially noted in the 'Remarks' column as to location, character of work and cost.

"(I) Safe-Guards, Signs, Etc.: The safety inspection, care, upkeep, repair, painting, strengthening, extension, addition and renewal of all railings and other safeguards (exclusive of those on structures); also similar maintenance and renewal of signs of warning, direction and mileage, and additional provision therefor as traffic safety, need and convenience may require.

Under this head shall be listed any expenditure in the proper care, upkeep and general maintenance of highway traffic conveniences such as watering places, drinking fountains, springs, rest or comfort stations, which are or may be provided for free public use in connection with the highway. Special note of such expenditures shall also be made in the 'Remarks' column, giving location, character and cost.

"(J) and (K). Blank lines are left on the forms opposite these letters, which the engineer may use, if necessary, to designate any item or class of maintenance work or expense, which in his judgment cannot fairly be listed under any of the defined item headings.

"While thus offering expansion opportunity for local needs, engineers are urged to make most careful review of the definitions of all items printed on the form, before adding thereto. It is believed they will be found inclusive of all classes of work and expense into which maintenance costs need be segregated. For uniform reporting and cost comparisons throughout the state, it is important that no change or addition be made unless absolutely compelled by local requirements and demonstrated to be necessary to the approval of the State Highway Commissioner.

"(L) Industrial Insurance: The payments required and made for industrial insurance, medical aid, compensation for injuries and disabilities, so far as such payments are made from state or county funds on account of workers actually employed on highway maintenance. Such payments to be apportioned to various highway sections on the basis of the men employed and expense actually incurred on each section.

"(M) Equipment and Supplies: General maintenance equipment, tools, etc., including any pits or quarries for maintenance materials with the facilities for utilizing same; also any materials or supplies for general maintenance use, which cannot be directly charged and segregated to the appropriate items is to be employed in all cases where feasible.

"In preparing the 'Annual Cost Estimate' there shall be listed on the separate form provided therefor, in general summarized items, all anticipated requirements of the county for General Maintenance Equipment and Supplies, which will be applicable for use on various sections of highways maintained under county authority, and whose cost must therefore be apportioned rather than directly charged to separate sections. Opposite each such item shall be noted its estimated total cost for the ensuing annual period, and in the columns following the apportionment thereof (a) to all primary highways, and (b) to all other highways, in the fair proportion of relative application of such item to the respective groups of highways. The total of amounts thus apportioned to all the primary highways in the county shall then be distributed as between the various sections into which they have been divided for estimates and reports, in fair proportion of relative application of such item to the respective sections. The amounts thus distributed shall be entered in the appropriate column at the bottom of the form before described, and the respective distributed amounts shall be inserted for 'Equipment and Supplies' on the 'Annual Cost Estimate' for the respective primary highway sections.

"In preparing each 'Monthly Report of Expenditures,' similar procedure shall be followed, using the separate form provided therefor, making statement of all county expenditures during the month reported for all General Maintenance Equipment and Supplies which cannot be directly segregated, the apportionment thereof as between the two groups of 'primary' and 'all other' highways, the distribution of the total apportionment as between the respective sections of primary highways, and the entering of such distributed amounts in the appropriate place on the monthly report forms.

"(N) Supervision: Special maintenance engineering, inspection and other supervision, also accounting and keeping office records of maintenance, with such supplies and other necessary expense incident thereto, so far as same are applied to general county highway maintenance and cannot fairly be included in payrolls and accounts directly segregated to the particular work to which applied—which direct segregation should be made whenever possible.

"In preparing the 'Annual Cost Estimate' and each 'Monthly Report of Expenditures' the separate forms consolidated with 'Equipment and Supplies' shall be used, appropriate spaces being provided for 'Supervision' entries. The same requirement of itemized statement covering all County Maintenance Supervision, its apportionment between the two groups of highways and distribution between the sections of primary highways, as provided above for 'Equipment and Supplies' shall also be applied in entering, apportioning and distributing 'Supervision' expenditures.

"(N. B. The salary or compensation of any regular county officer, road district supervisor or county employe, whose position or employment and compensation is not for the purpose of or dependent upon highway maintenance duties, but who may give attention to same in connection with other county duties, shall not be charged or apportioned against the maintenance of primary state highways.)

"(O) Contingencies: The regulation of the State Highway Board requires that the annual estimate 'shall include, in addition to all definite items listed, an item of not less than ten (10) per cent. of the total of all other items for contingencies.'

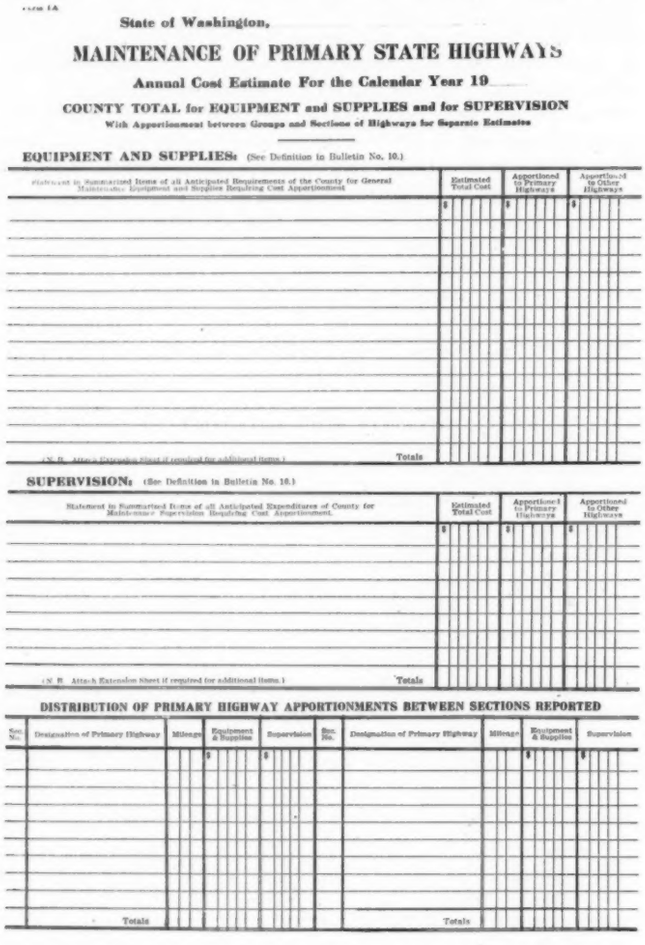
"In preparation of 'Monthly Reports of Expenditures,' any class of work or expense which can properly be classed as a 'contingency'—i. e., not contemplated in the making of the annual estimate—shall be entered opposite the appropriate item of segregation, even though it increases same and creates a deficit for that item in comparison with the approved estimate or advisory budget.

"A description of the location, character and cost, with statement of the cause of every such 'contingency' expendi-

ture, shall also be entered in the space provided therefor on each monthly report form.

Special Instructions

"Referring to the column headings on the 'Annual Cost Estimate' form, it is intended that the first column shall be used to furnish the County Commissioners with figures available for convenient comparison when considering the ensuing year's estimate in the second column. At the time of preparing the annual estimate in December, the engineer manifestly cannot insert precise totals for the 'preceding year' until he knows actual December expenditures. He should therefore enter eleven months total from actual reports plus an estimate for December. (For the 1918 estimate the 'preceding year' expenditures will be derived from the monthly re-



State of Washington, _____

MAINTENANCE OF PRIMARY STATE HIGHWAYS

Annual Cost Estimate For the Calendar Year 19____

COUNTY TOTAL for EQUIPMENT and SUPPLIES and for SUPERVISION

With Apportionment between Groups and Sections of Highways for Separate Estimates

EQUIPMENT AND SUPPLIES: (See Definition in Bulletin No. 10.)

Statement in Summarized Items of all Anticipated Requirements of the County for General Maintenance Equipment and Supplies Requiring Cost Apportionment	Estimated Total Cost	Apportioned to Primary Highways	Apportioned to Other Highways
	$	$	$
(N. B. Attach Extension Sheet if required for additional items.) Totals			

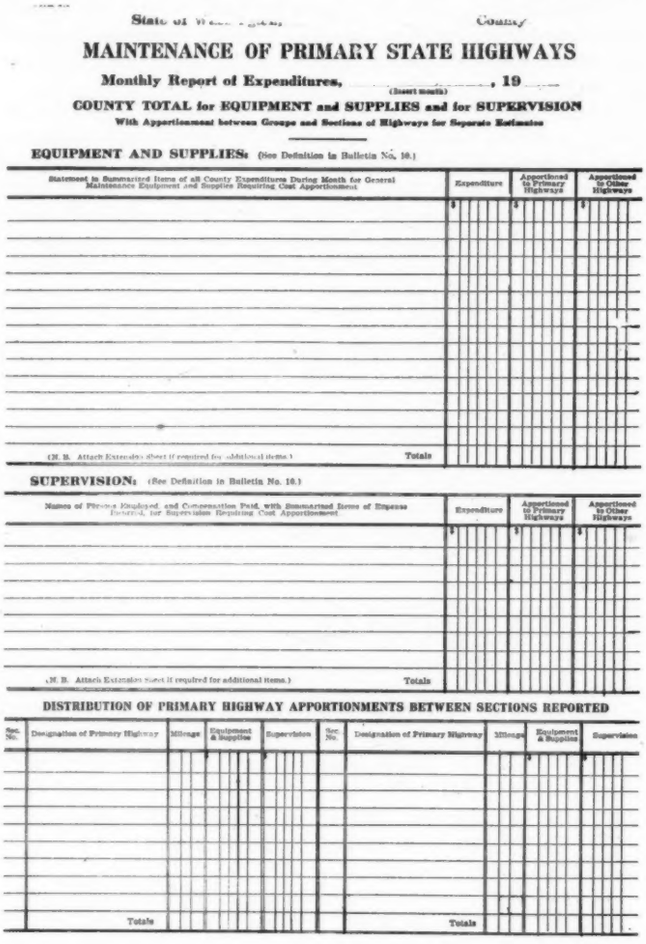
SUPERVISION: (See Definition in Bulletin No. 10.)

Statement in Summarized Items of all Anticipated Expenditures of County for Maintenance Supervision Requiring Cost Apportionment.	Estimated Total Cost	Apportioned to Primary Highways	Apportioned to Other Highways
	$	$	$
(N. B. Attach Extension Sheet if required for additional items.) Totals			

DISTRIBUTION OF PRIMARY HIGHWAY APPORTIONMENTS BETWEEN SECTIONS REPORTED

Sec. No.	Designation of Primary Highway	Mileage	Equipment & Supplies	Supervision	Sec. No.	Designation of Primary Highway	Mileage	Equipment & Supplies	Supervision
			$	$				$	$
	Totals					Totals			

FORM 1A OF THE WASHINGTON HIGHWAY MAINTENANCE COST KEEPING SYSTEM FOR ANNUAL COST ESTIMATE FOR EQUIPMENT, SUPPLIES AND SUPERVISION.



State of _____ County

MAINTENANCE OF PRIMARY STATE HIGHWAYS

Monthly Report of Expenditures, _____ (Insert month), 19____

COUNTY TOTAL for EQUIPMENT and SUPPLIES and for SUPERVISION

With Apportionment between Groups and Sections of Highways for Separate Estimates

EQUIPMENT AND SUPPLIES: (See Definition in Bulletin No. 10.)

Statement in Summarized Items of all County Expenditures During Month for General Maintenance Equipment and Supplies Requiring Cost Apportionment	Expenditure	Apportioned to Primary Highways	Apportioned to Other Highways
	$	$	$
(N. B. Attach Extension Sheet if required for additional items.) Totals			

SUPERVISION: (See Definition in Bulletin No. 10.)

Names of Persons Employed, and Compensation Paid, with Summarized Items of Expense Incurred, for Supervision Requiring Cost Apportionment	Expenditure	Apportioned to Primary Highways	Apportioned to Other Highways
	$	$	$
(N. B. Attach Extension Sheet if required for additional items.) Totals			

DISTRIBUTION OF PRIMARY HIGHWAY APPORTIONMENTS BETWEEN SECTIONS REPORTED

Sec. No.	Designation of Primary Highway	Mileage	Equipment & Supplies	Supervision	Sec. No.	Designation of Primary Highway	Mileage	Equipment & Supplies	Supervision
			$	$				$	$
	Totals					Totals			

FORM 2A OF THE WASHINGTON HIGHWAY MAINTENANCE COST KEEPING SYSTEM FOR MONTHLY EXPENDITURE FOR EQUIPMENT, SUPPLIES AND SUPERVISION.

ports covering June to November, 1917, plus an estimate for December.) If actual December figures are available before the board approves the estimate, the totals in this column should be revised so as to include them, but there should be no delay in preparing, approving or certifying the Annual Cost Estimate on this account. The figures in this column are memoranda rather than records, and eleven months of accurate figures plus the December estimate will serve the purpose of comparisons.

"Referring to the column headings on the 'Monthly Report of Expenditures,' it is intended that,

"(a) In the first column shall be entered the segregated expenditures for the month reported;

"(b) In the second column enter the sum of the similar segregated expenditures for all months in the calendar year preceding the month reported;

"(c) In the third column enter the totals of segregated expenditures for the calendar year to date, including the month reported, in all cases being the sum of the figures in the first and second column opposite each item;

"(d) In the fourth column enter the unexpended balance remaining from the advisory budget total for each item as approved in the 'annual cost estimate' at the beginning of the calendar year, deductions being made therefrom on successive monthly reports to the extent of the expenditures for each month as reported. When these deductions lead to a deficit in any item, note the amount of the deficit with an asterisk [*], and include in brackets. In compiling and entering the total of this column, 'budget deficits' as to certain items should be offset against 'budget balances' as to other items, and the total should indicate the net balance (or deficit) applicable to that section of highway.

"Whenever in any month there shall have been no maintenance expenditures or apportionments chargeable to any section or sections of primary state highways, it shall not be necessary to use the regular monthly form, but the engineer shall in every such case certify on a sheet of similar size to said form, that there have been no such expenditures or apportionments chargeable to the given section (noting its number and designation), during the month stated. This certificate of no expenditures shall go to the County Commissioners and be transmitted to the State Highway Board the same as if it reported and segregated actual expenditures.

"The engineer shall prepare each 'Annual Cost Estimate' and 'Monthly Report of Expenditures' in duplicate—one copy shall be kept by the engineer as a county record, the other

certified and transmitted to the State Highway Commissioner for the records of the State Highway Board.

"At the conclusion of each calendar year the engineer shall prepare a consolidated report of expenditures for the entire year, being the sum of the twelve monthly reports which have been rendered. Unless a special form shall be prepared and furnished therefor, the engineer shall use a monthly report form for this consolidated annual report, inserting the calendar year where the form provides for entering the month. This consolidated annual report of expenditures shall be certified to the County Commissioners and to the State Highway Board, at the same time as the monthly report for December. The engineer's file of reports for each section, including its initial annual cost estimate, the twelve monthly reports of expenditures and the consolidated annual report covering and closing the year, shall be deposited with the County Auditor, and remain available as a county record."

Records for Two Years Now Available

Two years of cumulative cost-keeping records of Washington primary highway maintenance are now available. They cover about 250 separate sections of highway, each averaging nearly 6 miles length; including 11 types of construction and surfacing. Their maintenance is under the direct administration of 30 Boards of County Commissioners and their county or maintenance engineers in charge. With an average of about 50 miles of primary state highway in each county, the maintenance organization covers these along with the larger group of main county and tributary highways, making the necessary apportionments for 'overhead' supervision, equipment, etc., as between the respective groups.

Argument for Joint System of State Control and County Administration

It may be opportune to emphasize the point just stated as the economic basis which supports the argument for county administration of maintenance of primary state highways under state regulation, as compared with direct state administration. Inasmuch as every county has and must continue in any event, its organization and equipment for the maintenance of several hundred miles of county highways over which it has sole jurisdiction, is not this existing county organization best equipped to cover most economically and efficiently the 50 to 100 miles of state highway within the same county territory? Is it wise or necessary to duplicate maintenance equipment and organizations by superimposing a separate state maintenance administration upon the relatively small proportion of primary highway mileage within each county? Will not a centralized State Highway Department control and direction of county maintenance administrations applied to primary state highways, with state authority to prescribe and enforce standards of maintenance, and with requirement of uniform cost-keeping and records of the expenditure of the state funds apportioned for the upkeep of these main roads, best serve the common public purpose? Moreover, will not the tendency be to expand the application of the state-prescribed standards and requirements for adequate maintenance of the primary highways, to the other main and tributary county highways and thus uplift and establish the entire highway maintenance plan and organization in all the counties? Thus runs the argument for the joint system of state control and county administration as in force in Washington. There is another side to this argument and there are some decided offsets in favor of the concentration of all trunk highway maintenance under direct state administration, irrespective of county organizations and boundaries. The figures of comparative maintenance costs of similar roads in adjacent counties are suggestive of decided differences of efficiency between county organizations, which concentrated state administration should overcome.

(A) STATE OF WASHINGTON—PRIMARY HIGHWAYS

Expenditures for Maintenance, Repairs and Equipment, June, 1917-May, 1919.

Name of County	Year June, '17-May, '18 Mileage	Year June, '17-May, '18 Cost Per Mile	Year June, '18-May, '19 Mileage	Year June, '18-May, '19 Cost Per Mile	Annual Average Cost Per Mile-Year
Adams	25.28	$36.08	25.28	$112.58	$74.33
Asotin	2.27	283.10	2.27	50.00	166.55
Benton	38.84	359.38	44.67	390.40	374.86
Chelan	10.39	113.59	22.24	435.36	274.47
Clallam	76.45	267.31	76.74	522.80	395.05
Clarke	18.04	429.60	28.82	464.28	446.94
Columbia	19.63	557.11	23.46	447.35	502.23
Cowlitz	21.01	730.48	26.67	552.70	641.59
Douglas	23.17	108.68	31.69	432.51	270.60
Franklin	1.91	8.34	19.16	180.58	94.46
Garfield	5.78	982.49	5.78	288.80	635.65
Grant	20.68	143.89	38.31	246.67	195.28
Grays Harbor	69.93	596.88	76.17	864.53	730.70
Jefferson	31.84	237.67	34.81	334.25	285.96
King	119.68	928.16	119.68	954.65	941.41
Kittitas	75.88	219.68	98.28	159.71	189.70
Lewis	77.90	157.31	77.90	463.88	310.60
Lincoln	39.45	354.65	69.03	254.82	304.73
Mason	46.50	165.13	52.07	206.99	186.06
Pacific	37.56	139.70	55.65	375.61	257.65
Pierce	81.47	160.81	86.24	402.92	281.86
Skagit	27.00	536.20	27.25	417.14	476.67
Snohomish	42.41	234.48	44.12	157.36	195.92
Spokane	94.57	171.93	106.29	544.57	358.25
Stevens	8.91	164.62	8.91	339.08	251.85
Thurston	50.17	165.51	56.49	257.98	211.75
Walla Walla	40.55	320.58	45.69	297.81	309.20
Whatcom	13.48	163.03	21.06	227.85	195.44
Whitman	64.27	442.37	65.30	270.57	356.47
Yakima	118.85	173.77	122.76	291.63	232.70
30 Counties	1,303.87	$327.84	1,512.79	$419.86	$373.85

Cost Data

The tabulated statements which follow are a summary of the expenditures charged against the primary highways of Washington for their maintenance, repair and equipment therefor during the past two years (June, 1917, to May, 1919, inclusive), as reported by the county engineers in charge to the State Highway Commissioner. They are classified

A—By counties exercising direct administration;

B—By highways, as designated in the state primary system;

C—By types of construction and surfacing.

Interpretation of the Data

For correct understanding of the preceding tabular statements and making fair comparisons therefrom, it must be borne in mind,

(a) That the expenditures listed and averaged per mile include all charges upon the entire road, its drainage, roadbed, slopes, shoulders, etc., as well as the pavement or surfacing—everything that has been necessary for the adequate maintenance, repair and general upkeep of the highway.

(b) That equipment purchases make up about 15 per cent. of the total expenditures, varying from nominal up to 50 per cent. in the various counties, apportioned upon the respective highway sections to which applied. While this operates

(B) STATE OF WASHINGTON—PRIMARY HIGHWAYS

Expenditures for Maintenance, Repairs and Equipment, 1917-1918

Name of Highway	1917 (7 months June-Dec.) Mileage	1917 (7 months June-Dec.) Expenditure	1917 (7 months June-Dec.) Per Mile	1918 (Full Year) Mileage	1918 (Full Year) Expenditure	1918 (Full Year) Per Mile	1917-1918 Cost per Mile-Year
Pacific Highway	237.54	$45,875.29	$193.13	258.09	$107,171.13	$415.25	$384.24
Sunset Highway	227.99	43,578.31	191.14	281.16	93,218.02	331.54	330.11
Inland Empire Highway	310.14	51,746.94	166.88	336.93	136,132.45	404.04	360.58
National Park Highway	124.39	5,884.58	47.31	155.59	54,592.82	350.87	251.48
Olympic Highway	232.36	41,878.38	180.23	250.55	111,288.96	444.18	394.36
McClellan Pass Highway	71.27	20,295.53	284.77	79.27	50,731.67	639.98	584.05
Central Washington Highway	41.88	1,570.86	37.51	48.94	6,633.43	135.54	109.30
Primary Highway Total	1,245.57	$210,829.89	$169.26	1,410.53	$559,768.48	$396.85	$357.54

(C) EXPENDITURES 1917-1918, CLASSIFIED BY HIGHWAY CONSTRUCTION TYPES

Type of Surfacing	1917 (7 months June-Dec.) Mileage	Expenditure	Per Mile	1918 (Full Year) Mileage	Expenditure	Per Mile	1917-1918 Cost per Mile-Year
*Brick Pavement	8.81	$9,456.51	$1,073.38*	8.81	$6,652.29	$755.08*	$914.23*
Cement Concrete	90.59	5,110.60	56.41	102.38	11,427.54	111.61	106.12
Asphaltic Concrete	19.74	322.21	16.32	23.24	7,871.09	338.68	224.21
Bitulithic and Warrenite	14.41	3,040.50	211.00	17.77	5,143.54	289.45	316.07
Sheet Asphalt	5.97	326.05	54.61	5.97	207.07	34.68	56.39
½ Width Concrete ½ Width Macdam and Concrete	7.80	1,798.50	230.58	8.53	2,461.81	288.61	327.91
Bituminous Macadam	42.21	5,895.67	139.67	40.96	20,071.85	490.03	397.70
Water-bound Macadam	122.85	20,297.41	165.22	125.05	52,335.59	418.52	368.67
Crushed Rock Surfacing	54.03	8,396.81	155.41	66.30	32,063.53	483.61	403.59
Gravel Surfacing	756.33	138,199.34	182.72	825.81	353,845.15	428.48	386.02
Natural Earth Grade	121.28	10,511.82	86.67	182.13	30,185.56	165.73	159.42
Special, Bridges, Trestles, etc	1.55†	7,474.47	.....	3.58†	37,503.46	.....	.....
All Types—Total	1,245.57	$210,829.89	$169.26	1,410.53	$559,768.48	$396.85	$357.54

*Abnormal expenditures on brick pavements due to extensive repairs and replacements account faulty construction and road-bed settlements. The 1917-18 average per mile year obtained by adding annual averages and equal division of sum. In all cases of other types than brick the 1917-18 mile-year average is obtained by dividing sum of annual averages by 1.5833, on account 7 months of 1917 averaged with full year 1918.

†This item represents unusual expenditures on bridges, trestles, etc., such as replacements, redecking, etc., amounting practically to reconstruction, and therefore excluded from ordinary maintenance costs of the highway sections in which located.

fairly as a general state average, there are disproportionate equipment charges as between the several counties, which will not work out in fair comparison until at least four or five years of continuous records on this plan are made available.

(c) That the traffic on the various sections of highways included in these statistics varies from 100 to 200 vehicles per day (in such counties as Adams and Franklin) up to 2,000 to 4,000 vehicles per day (in such counties as King, Pierce and Spokane on the highways tributary to Seattle, Tacoma and Spokane). Any comparisons between the relative county averages of cost of maintenance per mile, must take this volume of traffic into consideration, especially in the case of macadam and gravel-surfaced highways.

(d) In general, and to a marked extent in certain counties, the cost statistics are made higher than ordinary maintenance should be, by the inclusion of incidental improvements to the highways, such as occasional widenings, additional drainage facilities, bank protection along streams, providing guard-rails and other safeguards of traffic, removing slides, etc. Most of the Washington primary highways are new construction of the past six years, and under a liberal application of the terms "maintenance and repairs" any defects or minor errors which are revealed by use and with the effects of the elements at recurring winter and flood seasons, are supplied and overcome from the maintenance funds. Thus, with the exception of pavements and structures, it can be demonstrated that the Washington primary highways have been decidedly improved by continuing maintenance more than they have been worn out by the traffic. Maintenance expenditures should tend to decrease its comparison with the record of the past two years, because of these incidental improvements and repairs of new construction which have been liberally classified and charged to maintenance.

(e) On certain sections of the McClellan Pass Highway in King county, and of the Olympic Highway in Clallam and Gray's Harbor counties, the Federal Government spruce operations of the war period imposed a most abnormal and destructive use upon more than 100 miles of gravel-surfaced highways. Extension trucks carried great logs, often to aggregate weights of 20 to 25 tons, over miles of roads unfitted for such abnormal use; but with no other transportation resource from the spruce forests, these roads were devoted to the national service. In order to keep up these roads under such traffic it required on the McClellan Pass Highway in King county an expenditure during 1918 of $1,861.37 per mile for the 19-mile section east of Enumclaw, which was the scene of the spruce hauling operations. Similarly on the Olympic Highway in Gray's Harbor county south from Lake Quinault, it cost almost $1,000 per mile to keep up the 37 miles of gravel-surfaced highway during 1918. These abnormal upkeep costs swell the figures for these counties and types of highway.

(f) The years covered by these tabular statements—beginning with June, 1917, have witnessed the highest scale of labor and material costs ever known. Common labor had reached the $3.75 mark before June, 1917, and rose to $4.50 and $5.00 during 1918, at which level it remains in June, 1919 (for day of eight hours). This represents a full 100 per cent. increase from the $2.25 to $2.75 rates for similar labor in the pre-war period. And the materials necessary for maintenance work have risen in almost similar doubled proportion. The Washington primary highway average of almost $400 per mile maintenance cost in 1918—and five months of 1919 shows a continuance at about this rate—is fairly comparable with $200 per mile during the period of 1910-16.

Economy of Paved Highways

At least one general conclusion is fairly deductible from the Washington figures of two years maintenance costs, viz: That there is a gap of $250 to $300 per mile per year between the group of hard-surface paved highways and the macadam-gravel group. Considering further that the paved highways carry a volume of traffic per mile, averaging two to ten times that of the macadam-gravel group, it is demonstrable from detail analysis of sectional reports that macadam-gravel sections under traffic comparable with paved sections are costing from $600 per mile per year and upwards for their upkeep. In other words the real gap between maintenance cost of paved and macadam-gravel highways under similar heavy traffic is at least $500 per mile per year. Assuming a traffic of 500 motor vehicles per day or 182,500 per year, it is certain that not less than one cent per mile—some would place it as high as two cents—will be saved to the motor-operating public, or $1,825 per year per mile in actual upkeep cost of motor vehicles employed, to say nothing of increased traction results, time saved and convenience served. Adding the $500 per mile of increased annual maintenance cost and $1,825 per mile of motor vehicle upkeep cost, makes a showing of $2,325 per year per mile which can be saved by substituting a hard-surface pavement for macadam or gravel-surfacing. Half this amount would pay the interest on an investment of $25,000 per mile in pavement.

Whenever the traffic on a macadam or gravel-surfaced highway approaches an average of 500 motor vehicles daily, the Washington experience demonstrates costs of $600 to $1,000 per mile for such ineffective degree of upkeep as is possible for these highway types under such traffic. In every such case a hard-surface pavement is economically overdue, and the Washington program is to get these roads up-to-date by hard-surface construction as fast as resources and credit will permit.

New Mechanical Methods Employed with Marked Success in Building Monolithic Brick Road from Ashtabula to Conneaut, Ohio

By F. A. Churchill, Conneaut, Ohio

(Editor's Note: By means of the two automatic templates which are being used for fashioning the concrete foundation of the Ashtabula-Conneaut monolithic brick road, the contractor is able to construct from 1,000 to 1,100 ft. of monolithic, 16 ft. pavement in a day, including foundation and final grouting. This piece of construction work is attracting much well deserved attention. The following article, prepared at our special request, does full justice to this truly noteworthy piece of modern highway construction.)

Progress in road-building methods seems to advance in sudden jumps rather than by means of slow development, and this applies as well to mechanical devices as to designs and types of construction.

It was only about four years ago that monolithic brick pavements began to attract notice, yet monolithic and semi-monolithic construction—two forms of the same thing—have practically eliminated the old sand-cushion type of construction.

Early Monolithic Brick Surfaces Sometimes Rough

Until very recently, however, the process of screeding and shaping the green concrete foundation for monolithic brick road was rather slow and required extreme care in order to get a smoooth, even surface. The usual method was to employ a wooden template, steel shod, moving on side forms, which was drawn over the concrete by means of the concrete mixer. Inequalities in the surface contour were equalized by filling and hand luting.

Very good results were obtained by this method, yet unless the contractor exercised care, and if the concrete happened to be dry and coarse aggregate appeared at the surface, there would be dragging of course aggregate by the blade of the template and the brick surfacing might not be as smooth as desired. In fact, one of the complaints against monolithic brick pavements was that it was likely to be rough. While the unevenness of surface could easily be avoided, measures to avoid it were not always adopted by the contractor who was in haste to complete his job.

All difficulties of the kind mentioned appear to have been obviated by mechanical means, and henceforth there need be no rough monolithic brick surfaces.

On a State—and Federal—aid road in Ashtabula County, Ohio, the main highway leading from Cleveland to Buffalo, some remarkable work is being done in preparing green concrete foundations by mechanical means, and the uniqueness and efficiency of the means employed are attracting engineers and officials from all parts of the country.

This road runs from Ashtabula east to Conneaut and it is 12 miles long. The brick roadway is 16 ft. wide, with an additional 2 ft. of concrete gutter on one side. A 4 in. wire-cut lug brick is being laid on a green concrete foundation 5 in. deep. About midway of the terminals a small lake fed by a running stream furnishes the water, the latter being pumped through iron pipes along the roadway by means of a power pump.

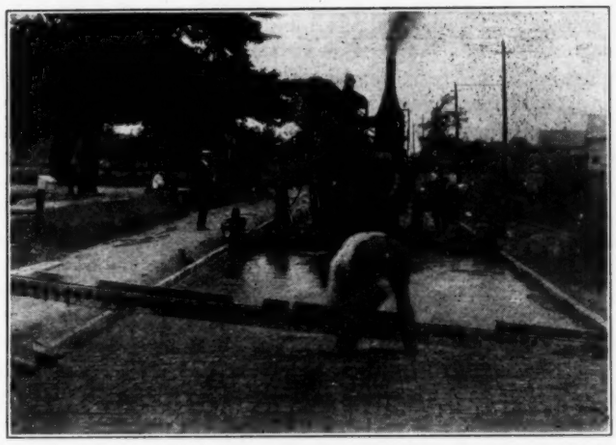
Parrish Automatic Cutting and Tamping Template Employed

As this road is the main thoroughfare for eastern and western travel in northern Ohio, and carries an enormous traffic, it was desirable to expedite its construction to the utmost possible extent without sacrificing good construction. The serious problem of time involved the factor of preparing the green concrete foundation to a true surface, and this problem has been solved by the use of a Parrish automatic cutting and tamping template which is self-propelling.

The template operates on wheels on the steel side forms used to hold the concrete to line. It operates and advances by its own power, always in a forward direction, just behind the Foote concrete mixer but is in no way connected with the latter.

The automatic template cuts the concrete base to a true contour a little higher than the required height of the finished surface, and then the rear section of the template tamps and vibrates the concrete to the true level and contour, leaving the surface as smooth and even as a billiard table.

The face of the tamping template is shaped to the true required contour of the pavement, as the mechanism is so adjusted that, always advancing, it delivers 65 successive taps on each section of the foundation covered by the face of the tamper. These blows are light, but they are delivered rapidly and the result is not only a perfect foundation contour and a uniform bedding course for the brick, but a thoroughly compacted foundation of uniform consistency throughout, without air pockets or other voids or inequalities of structure. The tamping also brings to the surface, if desired, a matrix in which the brick become imbedded.



PARRISH AUTOMATIC CUTTING AND TAMPING TEMPLATE and FOOTE CONCRETE MIXER AT WORK ON ASHTABULA-CONNEAUT HIGHWAY, OHIO, MAIN ROAD FROM BUFFALO TO CLEVELAND. MONOLITHIC WIRE-CUT LUG BRICK CONSTRUCTION, STATE AND FEDERAL AID ROAD 12 MILES LONG.

The absolute uniformity of the surface produced on the green concrete and the uniform density of the concrete assure an even and firm bearing for the brick and realize the principle of rigidity of beam to the fullest possible extent.

The Parrish template was used for the first time in regular contract work by its inventor in Illinois, and it is doing perfect work on this road. It operates below the rail as easily as on a level with the rail, and its possible rate of progress is declared by the contractor to be twice that which his big Foote power concrete mixer is able to provide for, or the brick layers to maintain.

Thomas P. Fitzgerald, the contractor, who is using two of the Parrish automatic tamping templates, says that he is building from 800 and 950 sq. yds. of monolithic brick pavement complete in an 8-hour day, with each machine, and he avers that there is a great saving per square yard in labor and material as compared with the cement-sand film construction.

In an interview, Mr. Fitzgerald said: "The tamping template is a great saving to contractors; also it makes better construction work."

The points of advantage possessed by the Parrish template are: It works below rails, or on a plane with them; it keeps going ahead without reverse action; it tamps rapidly; it moves ahead at any desired speed; it makes a dense foundation with a true, smooth surface, and it makes the concrete of uniform consistency without air holes or other voids.

Description of Parrish Template

Described in general terms, the template framework is of I-beams, with cross-bars to support the gasoline engine which operates it. The front I-beam acts as a cutting blade, set a trifle higher than the required height of the finished foundation. To the rear of that, and attached to the ends of rocker-arms, is a U-shaped channel iron beam set with the edges down, which spades the concrete. At the opposite ends of the rocker-arms, and rear of the spader, is a channel beam 3½ ins. wide on its face, which acts as a tamper, consolidating the concrete and finishing the surface to a true contour.

The ends of the transverse I-beams of the frame are attached to flanged wheels which run on the side forms placed to hold the concrete in place on the roadway. The motive power is a gasoline engine placed in the center of the framework and geared to the shafts. Clutches and levers regulate the speed, and stop and start the machine. Small steel cables, wound around drums on the template and carried ahead and anchored to driven stakes, draw the template forward evenly and steadily. The clutches on the drums operate independently so that the template can be adjusted to work on curves.

The cutting, spading, and tamping members can easily be set to operate at any required depth below the side forms, or on a level with them.

The template is mechanically simple, yet extremely efficient, easily learned and not complex, or delicate in mechanism.

Great interest has been excited by the methods used in constructing this important highway. Engineers, county officials and contractors from other states have visited the work for the purpose of inspecting the template and constructional work being done on the road, and even federal officials connected with road building have manifested an interest in what promises to be revolutionary methods of constructing not only monolithic brick but also concrete roads, since the template seems equally well adapted for finishing concrete slabs.

This new mechanical equipment for road building marks the beginning of a new era in highway construction, as distinctly progressive as the development of the new types of roads themselves, since more and better work can be done, and hazards of unsmooth surfaces are virtually eliminated, so far as foundation surfaces are concerned.

Design and Construction of the Telephone and Telegraph Tunnel Under the Chicago River at Harrison Street

By Wm. Artingstall, Consulting Engineer, 730 Old Colony Building, Chicago, Ill.

In laying conduit for cables, it has generally been understood that the nearer the conduits are kept to the surface of the ground, the less will be the cost of the installation. Sometimes, however, this does not hold true, even where there is no pavement to replace, and the Chicago Plant Division of the Western Union Telegraph Co. has just completed one of these exceptions.

Everybody knows that the Chicago River and its two main branches, roughly forming a big Y, with the stem connecting to Lake Michigan and the branches extending to the northwest and southwest, divides the city into the three divisions—North, West and South. The wholesale district, railway terminals, and main retail stores in the "Loop" are all within a mile of the junction of the two branches of the river. All the large office buildings lie within the loop, and it is in this section that the company is just completing their new building. Just west of the river are two large railway terminals, the Northwestern (lately completed) and the Chicago Union Station which accommodates several trunk lines and is now constructing a new terminal station at a cost of over $20,000,000.

Western Union Layout

The Western Union has a pneumatic tube system and cable run which forms a sort of belt between the main building, its branch offices and the various railway terminals. One side of this belt crosses the Chicago River at Harrison street and passes through the new Union Station. The enormous expense of maintaining marine cables in the river and the pneumatic tubes in the run compelled the use of a tunnel for the river crossing. The railway yard lying immediately west of the river could, under ordinary circumstances, be crossed by conduits, but the plans of the Union Station Company contemplated the lowering of their yard from 4 to 8 ft., without interruption to train serivce. A large concrete sewer had just been built and, on account of the numerous other conduits, water-mains, viaduct columns, subway reservations, etc., there was very little room available for our work and what was available had to be reached by first passing under the new sewer, several deep manholes, etc., and keeping sufficiently low to clear the railroad at its proposed grade. This meant expensive trenching under 18 tracks, 6 viaduct abutments, in various stages of collapse, and passing under a wide street intersection with more than the usual number of manholes, water mains, sewers, conduit runs and two lines of street railway tracks. Needless to state, the difficulty of laying conduit in a 10 to 14 ft. trench is sufficient without the additional burden of maintaining railway traffic of over 200 trains per day.

Chicago Telephone Co. Layout

The Chicago Telephone Company was in somewhat of the same fix as the Western Union, and had employed the writer as Consulting Engineer to develop a design for this crossing and maintain their cables during the construction of the new station. A complete study was made of the location and all the conditions entering into every feature of the work was thoroughly worked out. Four schemes were the result of these studies and estimates and, on the basis of the engineer's recommendations, the telephone company decided to construct a tunnel under the river approximately 500 ft. long and 90 ft. below the street surface. The Western Union decided to lease space in this tunnel, but later joined with the telephone company on an equal basis, so that now each owns half a tunnel. This took care of the river section, but the worst part of the run was still unsolved. Having participated in many conferences between the two wire companies, the writer was familiar with the Western Union problem and when engaged as consulting engineer by the latter company, he had no hesitancy in recommending that a small tunnel be designed so as to connect with the "joint" tunnel under the river, be projected west under the railroad yards, and come out in a manhole shaft on the west side of Canal street to connect there with the rest of the surface run. An estimate of cost was made to cover this scheme which ran less than the engineer's estimate of the cost of a conduit run. Considerable doubt was expressed as to accuracy of the estimate for the conduit run, so the engineer prepared complete designs and specifications covering

1st. A conduit run (with pneumatic tubes) located as close as practicable to the proposed track grade.

2nd. A small tunnel, shafts, manholes, etc., between the same points as proposed for the conduit run.

The Joint Tunnel

The intention was to submit both designs to contractors for competitive bids. Only one contractor was willing to take a chance on the first proposition, so after informing the "main office" that propositon number one would cost slightly over 50 per cent. more than the tunnel, providing the company took all the risks for damages, it was decided to withdraw the designs of the conduit run and submit only the tunnel designs for bids. Designs for the joint tunnel were submitted at the same time; James A. Green & Sons were low bidder in

each case and were awarded the contracts for both jobs. The small tunnel was estimated to cost $20,010; the bidding price was $19,955, while the final certificate called for $19,572.22. The large tunnel was estimated to cost $34,450, and cost $33,491.76. Certain work was later decided to be done and given to the contractor at a cost of $4,037.35, so the whole work cost in round numbers, $57,000.

The east shaft, called No. 1, is located about midway between the river and Franklin street; shaft No. 2 on the opposite side of the river is 500 ft. west; shaft No. 3 connects with the C. B. & Q. Ry., while shaft No. 4 is the western terminal of the tunnel at Canal street and about 1,200 ft. from shaft No. 1. The invert at shaft 4 is at—40 city datum, or about 60 ft. below street grade, and the slope is to the east, where at shaft No. 1, the invert is at —70, or 90 ft. below street grade. The various details that entered into and governed the design will not be dwelt upon because they vary with each design and location and while interesting in themselves, they would occupy more space than can be given in an article of this sort.

Shaft Sinking

The first work on construction was shaft 1, the sinking of which proceeded without difficulty until within a few feet of the bottom, when just as the men were ready to quit work on the day shift, a small amount of seepage was noticed coming through the excavation. The next morning there was 60 ft. of water in the shaft. This was then temporarily abandoned and work started on shaft 2. This shaft is partly in a basement, partly through an old retaining wall (28 ft.) and partly under a filled street, carrying two car tracks. This formed the basis for an ideal lot of trouble if the work wasn't handled just right, but fortunately our fears were groundless, the shoring was placed and the sheathing driven without trouble of any kind. After the first set of lagging was set, the shaft was sunk in the short time of 15 days. This shaft is offset from the tunnel in order to clear a proposed viaduct pier, so the tunnel makes a curve at this point, on a radius of 80 ft., for a distance of 35 ft. to meet the line drawn between shafts 1 and 4. As we had only 6 ins. to clear another caisson at the junction and were compelled to extend the tunnel 500 ft. one way and 700 ft. the other, with a back sight base line of only 6 ft., the engineers on the survey were somewhat relieved when the tunnel was "holed-through" and they connected up at the shafts less than half an inch off line.

After shaft 2 was finished, the "eye" or section of tunnel at the foot of the shaft was excavated and concreted. This is always a nasty part of the work, and the fact of its being 14 ft. high and only 6 ft. wide, added nothing to its charms. A short distance from the eye, the tunnel widened suddenly to 12 ft. (This was to permit the small tunnel to pass on to shaft 4.) From this section toward the east the tunnel is drawn down to the regular section of the joint tunnel 6 ft. 6 ins. high and 6 ft. wide. To the west the tunnel is 4 ft. 6 ins. high and 4 ft. wide.

Splicing chambers 6 ft. 6 ins. high, 6 ft. wide and about 15 ft. long are provided at two points, one for a future connecting shaft to the Alton-Pennsylvania cables and the other at the foot of a small shaft to the new C. B. & Q. Ry. freight house. This latter shaft is only 3 ft. in diameter, but was expensive on account of having to be built on an incline to clear the trunk sewer before mentioned. No difficulty was experienced in the small tunnel except by some of the visitors, who found trouble in accommodating 6 ft. of height to a 4 ft. head room. The joint tunnel, however, made up for all the lack of trouble elsewhere.

From start to finish, there was one thing after the other. Sand and gravel in the roof, water coming in at the top and sides, cave-ins from everywhere, but the bottom, and this at places was a swelling clay. Practically every foot had to be timbered. Time after time, a second or third cave-in would occur before the timber could be placed. And I have seen the "face" of the excavation move into the tunnel more than 2 ft. in four hours. However, it was all completed in good shape and the contractors are entitled to considerable credit for their part of the work.

Concrete was used both for the tunnel lining and for the shafts but the manholes were built of brick with an I-beam and concrete roof. The cables are placed on racks spaced 3 ft. centers and supported by clamps in the shafts. Two emergency ducts are laid under the floor of the tunnel and carried up the shafts, so that in case of trouble with one of the cables, one or two new cables can be pulled in without waiting to pump out the water. Arrangements have also been made to install an automatic pump in case of necessity.

The designs were developed in connection with Mr. W. W. Watts, now Division Plant Superintendent Western District, and the construction carried on under the supervision of Mr. C. C. Bowers, line supervisor. Mr. M. B. Wyrick is Division Plant Superintendent in whose district the work was located.

Why Some Engineers in the Service of the City of Chicago Joined the International Federation of Technical Engineers, Architects and Draftsmen

To the Editor:

There has come to my hand a copy of the June number of Municipal and County Engineering, in the very frank and enthusiastic garb of an "American Association of Engineers" issue.

Not being among your subscribers I would, in view of your evident attitude, hesitate to address you were it not for your equally frank statements that you "looked on from the side lines for a good while before deciding to cooperate with the Association," and that "since this magazine is devoted to the interests of the engineer in public service, it is our clear duty to co-operate with the Association in this work."

I assume, therefore that though your mind is evidently made up for the present as to the relation of engineers to society in general and to its governmental activities in particular, you are still open to a frank and reasonable presentation of opposing views. The three editorials, the address of Mr. Stinchcomb, the three letters pertaining thereto, and the letter and salary table from St. Louis, all present a formidable appeal, but to many of us they appear to ignore certain facts and reasonings, and it is these which I have in mind in writing to you.

I cannot attempt to separate the presentations in the various articles, but desire merely to discuss three aspects of the whole question, namely: 1. The proper attitude of engineers toward public affairs generally; 2. The much-discussed question of "professionalism" in engineering, *per se;* and, 3. The related question, the proper attitude of men in technical pursuits toward labor unions.

I wish to say that I speak, first, as a "professional engineer," in the sense of your articles, being a graduate of Armour Institute of Technology, a member of the Western Society of Engineers, and a licensed Structional Engineer; second, as an engineering employe for 13 years, of the City of Chicago, with some outside experience, and third, as a member of the Chicago Local No. 14 of the International Federation of Technical Engineers, Architects and Draftsmen.

First, then, as to the engineers, and public affairs. Neither I, in any of the capacities above mentioned nor any of my acquaintances in those groups, have any but the highest commendation for what is being proposed in many quarters looking to the recognition of the vital relation of the engineer to every public activity. As a citizen, but infinitely more as an engineer, he has a right to a voice in those matters, and as a citizen and an engineer he has a right to a material return commensurate with his ability and responsibility therein.

As to "professionalism," however, there seems to be a wide

disagreement. If, as I judge, you hold that engineering from top to bottom is a "profession," then there is surely this disagreement. The great number of articles in the technical press in the last few years will certainly bear out this statement. The terms "profession" and "professional" themselves invite comparisons and yet, notwithstanding definitions, they are still so ambiguous as to make comparison almost impossible.

Although it is now true that in the so-called "learned professions," a school training and degree are required before permission to practice is granted, it was not always so. An apprenticeship to a member of the profession was formerly enough to admit a man to practice.

Engineering is perhaps the latest calling to emerge from this apprentice system, but it is emerging, as shown by proposals to license engineers in many sections of the country. When that becomes general there no longer need be any question as to the definition of "professional engineer." It will not be "one who does this or that"——but "one who has an engineer's license." Many inconsistencies may exist and many inequities, perhaps, but the title will be settled.

In the meantime, however, the hosts of young engineers and draftsmen are being urged and admonished by those older ones who have "arrived" not to forget the ideals of their "profession" nor the ultimate recognition which must come to consistent and persistent effort. The older man in his capacity of consulting engineer or manager or perhaps owner of large enterprises is interested greatly in low costs and so along with the admonition, the younger man has been receiving small pay and large promises for the future! But who has made it his business to remind the young man that he has only from one chance in fifteen to one in twenty to get even in sight of the top? And why, by the same token, is it necessary that the success of the *one* whose ambition and special fitness make him an executive, should so generally militate against the *nineteen* who are better fitted for and perhaps content with the jobs of turning out the work? *They* may be as good *engineers* as *he* or better, so far as mentality and technical training is concerned, and their work is as necessary to his success as his own.

The pith of the matter then should be in the answer to the question which you quote—"Shall Engineering be a profession or a trade?" I say it is and will be both, and especially if we accept the definition of a "professional man" proposed, I believe, by the present president of the American Association of Engineers, Prof. Newell; I quote from memory—"A professional man is one who tells a client what to do and receives for this service a fee."

If on the other hand we continue as other professions do not, to include in the profession, the wage earning, technical man, will it work out? Does the man class himself that way? Are there not thousands of draftsmen and engineers, field men, and office men who realize that *so long as they continue to do the work they are now doing in all sorts of industrial and municipal organizations, they* cannot *easily*, be distinguished from many of the groups of skilled labor? Endless attempts to make these distinctions appear invariably to fail either in reason or in actual comparisons. Great numbers of technical men realize this and realize, too, the truth of your statements that "affiliation with a national organization is highly desirable," that "They have tested to complete failure the old plan of individual effort," and that "the groups that remain unorganized can expect nothing better than the worst of it in the economic struggle."

Because they realized this, a group of Chicago draftsmen affiliated themselves, over twelve years ago, with The American Federation of Labor, knowing that they had nothing to hope for from the established engineering societies. Such groups multiplied, and while the old societies began slowly to take cognizance of the growing dissatisfaction among technical men, such groups continued to multiply, and why should they not? Because of the fear of strikes or other manifestations of organized effort? Even if it should come to this would there not be plenty of reason for it?

The editor of Engineering and Contracting, discussing this subject in the issue of Sept. 4, 1918, said "If engineers in high position are 'only human,' and therefore not always humane, engineers in low position can scarcely be blamed if they too prove 'only human,' even if in doing so they also prove shortsighted." He and many others, be it admitted, doubted the wisdom of unions for engineers, but could not deny the excuse. He says, "Tired of waiting for adequate salaries, a thousand draftsmen, many of them graduate engineers, have joined a labor union."

This is but one of four or five thousand scattered in 35 locals throughout the country but united in the International Federation of Technical Engineers, Architects and Draftsmen. Are these any less "National" in character than the American Association, which you give such great credit for that feature? You espouse the cause of the Association because "after looking on" you find it not a trade union and because being devoted to the interest of the engineer in public service, it is your clear duty to co-operate," etc.

Some of us who knew of the American Association of Engineers from its very inception, ascribe much of its success to date, to the leaven of unionism then present, and we think that to continue much longer in the esteem of the "ordinary" engineer and draftsman, it must return to those principles. Having watched at closest range, the drift of the Association toward that very "Chamber of Commerce" attitude which you so heartily approve, many of us have remained out of it. How else than with suspicion could the employed engineer view the election of a railroad president to the presidency of the Association? And how except with amusement or anger could they read the roster of the witnesses for the Association at a recent hearing before the Railway Wage Board? Their testimony has probably not been widely read but to the few who have had the privilege it is the best of evidence, not perhaps of the Association's ultimate destination, but at least of its direction of motion until very recently.

It is not, be it understood, without disappointment that we have seen this change in the American Association of Engineers, since many others than yourself "looked on from the side lines," but seeing ahead the shadow of the rock of "professionalism," stayed outside.

Quite naturally from the Association viewpoint, the action of the St. Louis engineers noted in your paper, is a notable event. When, however, 400 or 500 municipal engineers in New York, 300 in Chicago, and numerous government employes in Washington and elsewhere, besides private corporation employes throughout the country, turn to union affiliations, with a recognized international organization, is it not fully as notable in engineering annals, regardless of individual opinion as to its propriety?

Whether or not the St. Louis men have been successful in their matters, I have not heard as yet, but that Chicago Local No. 14 of the E. A. and D. U. has obtained recognition as a body and the payment of its scale, is now a fact.

I have even now trespassed on your good nature too far to permit further details of the scope and activities of these unions, but I hope you will be sufficiently "intrigued" to make other information acceptable.

Very truly yours,

Chicago, July 24, 1919. Tenney S. Ford.

Correspondent Suggests Road Tax on Gasoline

To the Editor:

Several months ago, while sitting at lunch in the hotel at St. Catherine's, Ontario, I got to talking with a stranger about good roads and the means of raising money for them. He sug-

gested that a tax on gasoline used in motor vehicles would be the most equitable means of raising funds. A little later, in looking through my files of literature on paving and road making, I ran across an article by Mr. Clifford Richardson, written many years ago, in which he discussed the same matter.

Some months past, I wrote an article suggesting the "Wheel Tax," which many of the magazines published. There is some analogy between the wheel tax and the gasoline or fuel tax, as both try to secure the money from the service they receive.

An annual tax on the "wheel" would not take into consideration how much the vehicle having the wheel was used during the year; while a tax on the "gas" would be in direct relationship to the actual use on the road. The more a vehicle is operated, naturally, the more gas it requires; also, the heavier the vehicle, the greater amount of gas it consumes per mile. Therefore, a tax on gas would most equitably compensate for the destructive use of the road by the owner of the vehicle.

The "gas" tax would, of course, present some difficulty. Means would have to be found for taxing vehicles not using gas; and there would surely be other flies in the ointment. One of these would be the necessity of the province or state carefully supervising the distribution of gasoline to users of road vehicles.

As the matter of raising money for road improvements seems to be the great stumbling block in the way of "good road" management and construction, it seems to me that this is a very vital issue today. I would like to see a much more exhaustive discussion on the subject of taxation for good roads than we have yet had.

Very truly yours,

C. A. MULLEN,

Director of Paving Dept., Milton Hersey Co., Ltd.

Montreal, Quebec, July 17, 1919.

Civic and Engineering Features of Grade Crossing Elimination

By Allen L. Golinkin, Recently Assistant Civil Engineer, Division of Bridges and Grade Crossings, New Jersey Public Utility Commission, 1105 S. Richmond St., Chicago, Ill.

A grade crossing is generally understood to mean the crossing of a railroad by a highway at the same level. The term is also applied to the crossing of one railroad by another railroad at the same level.

During the period when railroads were first constructed in this country it was neither practicable nor economically possible for either the railroads or the communities through which they passed to pay great attention to the matter of grade crossings. Later on when these sparsely settled communities grew into villages and afterwards developed into cities the necessity for protecting and eliminating grade crossings became more and more acute until of late years no single question affecting the relation of cities and railroads has received more attention. Like many another important matter of this character interest in the subject has lagged during the war but the fact remains that the question of separation of grades in cities and towns is vital and there is every reason to believe that it will receive considerable attention as soon as our internal conditions again become normal.

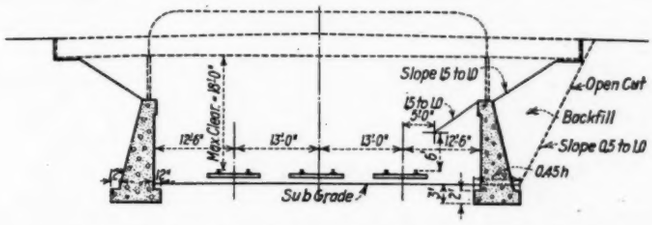
The history of the work of systematically eliminating grade crossings possibly dates back to the early eighties but it is only within the past 20 years that it has been the subject of much discussion and study. A striking amount of grade crossing elimination work occurs in Chicago where it is reported that over 800 grade crossings were eliminated up to 1912. Unquestionably this large number of crossings was necessitated by the low topography of the City but large numbers of eliminations are also reported for New York. Philadelphia also claims over one hundred to its credit and Buffalo over ninety. Despite this apparent activity dangerous grade crossings are still numerous, especially in the smaller cities, and much remains to be done in this matter.

Civic and Engineering Phases of the Problem

The problem of eliminating grade crossings can roughly be divided into two phases—the civic and the engineering. By the civic phase I refer to the agitation of the citizens of a community for the elimination of dangerous grade crossings within their community. Without going into a full discussion of this phase of the problem it appears that the final success of such agitation depends, in the last analysis, upon the attitude of the people towards human life. To the people of a town or city who are honestly convinced that the payment of a little additional tax or the disturbance of a few property values are minor items compared with the saving of human life there is practically nothing in the way of obtaining complete protection on all crossings and the elimination of the more dangerous ones. While this is purely a civic problem and has little direct bearing on the engineering phase, it does have some connection with it insofar as the agitation of the people must take a concrete form in partially financing the cost of the engineering work involved.

From the engineering standpoint I believe it is generally agreed that some method of grade crossing elimination can be worked out for any situation. This, however, does not mean that the engineering treatment of a grade separation is always a simple problem, but only that the difficulties encountered in topography, right of way trouble, and damage to property are rarely insurmountable. Given a competent engineer and sufficient funds it then follows that any grade crossing can be eliminated.

Unfortunately the elimination of grade crossings is not financially profitable either to the railroad or the city. Even



SUGGESTED SECTION FOR RAILWAY TRACK DEPRESSION SCHEME PERMITTING PASSENGERS AN UNOBSTRUCTED VIEW TO ORIGINAL GROUND LEVEL.

stressing the considerations of resulting convenience to the traveling public, the aid in the industrial development of the community, and the saving of time in both railroad and highway traffic, the fact remains that neither party can receive a financial return commensurate with the large amount of money expended.

Engineering Treatment of Grade Crossing Elimination

The following discussion includes some of the more general matters considered by the engineer in studying a grade crossing elimination project.

There are six methods by which a grade crossing can be eliminated:

(1) To leave the tracks at their original elevation and carry the street over them.

(2) To leave the street at the original elevation and carry the tracks over it.

(3) To leave the tracks at their original elevation and carry the street under them.

(4) To leave the street where it is and carry the tracks over it.

(5) To lower the street below the original elevation and raise the railroad.

(6) To raise the street above the original elevation and lower the tracks.

The last two methods noted are modifications of the first four and might be included in them.

In the choice of a final method for separation of grades there are many considerations but often one big element such as topography, geological conditions, or permissible railroad grade will definitely settle the scheme of treatment allowing for little choice in the other affecting matters. An instance occurs in Chicago where the ground is low and level, making depression absolutely out of the question on account of the interference with sewer and water systems, thus leaving the only alternative, elevation or partial elevation. However, there are many situations where grade separations are studied that allow for a wider choice, places located at the summit of ascending grades where depression might be used and again in level localities high above water where all elevation and depression methods can be considered.

In the preliminary study of a grade crossing project the following points should be given serious and constant attention.

(a) If practicable railroad grades should not be made excessive and due regard should be given the railroad to take advantage of the changes for promoting operating economies.

(b) Attempts should be made to benefit street traffic in addition to eliminating delay at crossings.

(c) Care should be exercised in creating a minimum of property damage and the usual currents of traffic should not be seriously diverted. In this connection it is well to keep in mind the fact that all property damage is chargeable directly to the cost of the grade crossing elimination.

(d) Since construction work on grade separation projects usually requires considerable time, attention should be paid to the inconvenience that will result to street traffic during the period. The frequent necessity for completely stopping both street and railroad traffic or building a detour around the entire project when depressing the tracks may often make this method inadvisable.

Other considerations of varying importance which invariably enter into elimination projects include the matter of resulting convenience to the traveling public in the arrangement of stations, elements affecting the industrial development of the community, and finally the aesthetic considerations which from the very nature of the project should receive full attention.

The number of crossings involved in the grade crossing elimination study is another element which has an important bearing on the method finally decided upon. In the case of a single crossing it is usually impracticable to change the railroad grade, for this would cause a hump in the grade line with long approaches and great expense, while the method of raising the street over the railroad track could be done much more effectively. In the case of a city or a thickly settled community where a number of crossings would probably be involved the plan of depressing or elevating the tracks and leaving the street grades alone would probably be the better scheme.

Excavation, Bridges, and Change in Street Grades

The subjects of excavation, bridges, and change in street grades are the specific problems involved in a grade separation study and are given special attention by the engineer.

The matter of excavation or fill is usually the ruling factor in estimating the cost of a grade crossing elimination project. To carry the tracks over the street requires a vertical separation of grade of from 16 to 18 ft., allowing for a depth of bridge floor of from 3 to 4 ft., and headroom of from 13 to 14 ft. To carry the street over the tracks requires a vertical separation of grades of from 22 to 26 ft., allowing from 18 to 22 ft. for clearance and 4 ft. for floor depth. In cases of depression the roadbed must also be wider because of the necessity for drainage. Considering the difference of from 5 to 10 ft., in vertical separation of grades for these two plans and the additionl item of increased roadbed makes the total quantity of material involved in the depression scheme considerably greater than that required for elevation. While additional cost of trestle in the elevation scheme and other items such as bridge costs, maintenance of traffic, and the nature of the material to be excavated may sometimes indicate in favor of the depression plan the larger item of reduced yardage will, in the majority of cases, overbalance them. The advantage of noninterference with sewers, water pipes and public service lines also counts materially in favor of the elevation plan.

Bridges for track elevation or depression are now made of steel or concrete, present practice being in favor of the latter, because it lends itself to better advantage of aesthetic treatment. The three general classes of structures used for track elevation are:

(1) Bridges spanning the entire width of the street with a single span.

(2) Bridges spanning the width of the street with two spans, a support being placed in the center of the street.

(3) Bridges spanning the street with three spans, one support at each curb line.

In all types the designer aims to obtain a structure which allows for a thin floor, the avoidance of any projection above the floor which might interfere with safety, and a form that allows for easy alteration in case additional track space is required. In the first type of bridge the arch can be used to good advantage. Bridges of the type having a support in the center of the street, have the objection of obstructing the roadway, which is most serious in the case of a boulevard, where it forms a barrier to the traffic and mars the appearance of the road and least objectionable on a street having a double car track where the space between the tracks itself tends to form a natural barrier between the traffic on both sides of the street.

In eliminating crossings the necessity often arises for changing street grades which in turn brings up the problem of allowable street grades, drainage, and interference with sewer, water and gas mains. Many cities have maximum grades fixed by ordinance ranging from as low a permissible grade as 3 per cent. (in Chicago), to 8 and 9 percent. in hilly cities like Washington, D. C., and Brockton, Mass. The general plan in most cities, however, is to keep the grades below 5 per cent.

In studying the effect of complete elevation or depression on a contemplated separation of grades the question often arises as to the advantage of partial elevation of the street or a partial elevation of the street with partial depression of the tracks. In practically all cases a slight change of 1 to 3 feet can readily be made in the street without causing serious property damage, expense or interference with view. This plan, however, is sometimes used to a real disadvantage where an attempt is made to obliterate the effect of a so-called "Chinese wall," by dropping the street elevation 4 or 5 feet. The dropping of 4 or 5 ft. on the street may often break up that desirable feature of continuity of view on the street without really changing the effect or appearance of the wall.

In carrying the street under the tracks it is sometimes possible to carry the roadway under at a lower elevation than the sidewalks. The difference in elevation between the sidewalks and the roadway may sometimes be made as much as 4 or 5 ft. at the deepest point, which allows for a maximum of clearance in the roadway where it is most desired.

Whenever streets are depressed suitable catch-basins should be placed with proper connections to sewers. Similar arrangements must be made when the tracks are depressed. Where streets are depressed so much as to interfere with the existing sewerage system the problem becomes serious and calls for either the designing of a new sewerage system or

the use of a siphon, both of which add tremendously to the cost of the project.

Comparison of Elevation and Depression Methods

Since the application of complete elevation or complete depression schemes still remains an open question in many situations, it might be well briefly to examine into the outstanding advantages and faults of each.

The elevation of railroad tracks over the street allows for more efficient railroad operation in so far as it requires no structures that might interfere with the proper display of signals. Elevation also makes it easier to keep the track clear of snow and avoids the necessity of providing difficult and costly methods of drainage.

In matters affecting the damage and inconvenience to adjoining property some difference of opinion still exists as to the relative advantage of fill or cut. In cases of depression it is clear that the locomotive smoke is discharged at street elevation which certainly causes a more decided nuisance than would occur were the smoke discharged at a considerable distance up as would be true in elevation. Again, the puffing of the locomotive which is responsible for most of the objectionable noises of a railroad is less noticeable on an elevated track. However, the "Chinese wall" effect of an elevated structure is an eyesore and is considered more objectionable in some localities than the noise and smoke.

With reference to construction, experience has proven that it is easier to elevate railroad tracks than to depress them, and that the inconvenience that results at street crossings during the period of construction is much less serious when the former method is used.

As to the relative merits of the two schemes in so far as the traveling public is concerned, the elevation method offers a perfectly free and unobstructed view, while most depression plans result in poor light, air and view for the traveler. If sufficient space exists this objection to the depression plan can be overcome to a large extent by using the section indicated in the accompanying figure. It will be noticed in this sketch that from a point 6 ft. above the track and 5 ft. from its center line (about the location of the passenger's eye in a coach), a 1½ line of sight exists to the top of the wall from which a 1½ earth slope is then carried to the street elevation. This results in a full light from the street to the coach window and allows for an almost unobstructed view and good air circulation.

With the item of expense again on the side of the elevation scheme, as pointed out in the discussion under excavation, and the additional advantages present in the foregoing factors, the elevation method of grade crossing treatment seems to be the better plan.

Lack of Expert Engineering Advice in Paving Matters Costs the Public Vast Sums

By Hugh W. Skidmore, Chicago Paving Laboratory, Consulting and Inspecting Engineers, 160 N. Wells St., Chicago, Ill.

Observation of actual conditions reveals the fact that far too many pavements are either badly designed, or that the best paving materials have not been chosen, or both. The steady increase of frequency and weight of motor-driven traffic has rendered this fact more apparent in recent years. It is also true that evidence of these short-comings is more noticeable in the smaller cities, villages and counties; due no doubt to the fact that expert advice is more frequently lacking here than in the larger cities and highway departments. Thus, local officials become easy prey to the promoter who is able to paint the rosiest picture.

Notwithstanding the fact that matters relating to paving and other public improvements are usually in the hands of boards of commissioners, or similar bodies, the members of which rarely have had any experience in such works, it is quite common to find that these bodies are averse to the employment of experts, and will often even refuse to heed the counsel of the local engineer. In general, this attitude is due to ignorance of the actual economy of expert service. It is not at all uncommon to find these men of the opinion that outside assistance is entirely unnecessary. In communities where this spirit prevails, the worst failures are most frequently found, and the poorest engineering is evidenced. Another class is that which will admit the advisability of employing the services of an expert (the cost of whch is always ridicuously small when compared with the cost of the project), but fear an avalanche of public protest would follow such an innovation. The local boards which do not regard with suspicion a proposal purporting to supply the necessary means of safeguarding the public investment represent a decided minority; yet it is doubtful whether anyone of the members thereof maintain the same feeling toward the employment of a first-class attorney to advise him regarding a business transaction representing a few thousand dollars, nor would he hesitate to seek the counsel of a physician even for a slight or imaginary complaint. The difference seems to be that the average man has not yet learned that he can ill afford to do without the services of an experienced engineer. Or, perhaps, it may be partly due to the fact that public funds (everybody's and nobody's money) is involved, and the expenditure thereof is not entirely free from the taint of politics.

A dissertation on the short-comings of the local administration of public improvements is not intended, but it is thought that perhaps one very serious obstacle in the path of proper education of the public, regarding the need and wisdom of employing sound engineering experience where it is needed, is here represented. The problem seems rather difficult of hasty solution, yet it is a most serious one, because vast sums of the people's money is invested annually in pavements. This expenditure should, and must be, properly safeguarded. More money is spent each year for paving and road building than for any other one item of public improvement, and there seems to be slight doubt that some of it is unwisely and improperly spent.

Federal and State aid will undoubtedly have a material effect in relieving the situation. Under the expert supervision of the engineers on these projects, good construction will follow, thereby setting an example. But this will not necessarily prove a cure; unscrupulous material men and contractors will still have many fertile fields. It is rather surprising in this day of enlightened business methods to find even a few material salesmen and contractors who seems to have entirely lost sight of the well known fact that the game must be played pretty much on the square, if one expects to continue doing business. Promoting by educational methods is efficient, also beneficial. A good job well done, a good article at a fair price, advertise themselves; but unfair methods, misrepresentation, calumniation of the others fellow's goods, cheating the job, unreasonable prices, etc., all contain the seed of self-destruction, and will ultimately ruin the habitual user.

Engineers are not altogether blameless in many instances. Often they have been given too much to the seeking of a convenient door through which they might gracefully retire from a bad situation; too often have they lacked the courage to raise their voices above a weak protest; entirely too often for the public welfare and the good of the profession, have capable engineers, experts in their line, stood aside and let some inexperienced local engineer go through with, or attempt to put through, a job, when they could have had the job for the asking, thereby giving the community a good piece of work instead of a poor one, and at the same time, providing the local engineer the best possible opportunity of enhancing his own education.

The employment of a special engineer to render expert

service will in no way interfere with the duties of the local engineer, since under such an arrangement, he usually serves as resident engineer. The duties of the engineer in the small town or average county cover a wide variety, such as drainage, sewerage, water supply, surveying, paving, lighting, parks, etc. Ordinarily such communities cannot afford the expense of employing a man with very extensive experience along so many lines. Therefore it is only logical that such communities continue to employ less experienced engineers at fair salaries to handle the general run of engineering work, and then employ special engineers on special work.

Before the situation can be entirely cleared, the laws in many localities will have to be revised, e. g., laws which provide that property owners shall select the materials and type of construction, regardless of the opinion of the engineer, simply create the greatest opportunity in the world for the promulgation of the propaganda of quacks. It is not advocated that the taxpayers be refused a proper hearing in such matters, but, for the general good, engineers generally must have more to say regarding matters their training and experience qualifies them to deal with.

It appears that the quickest and surest way out lies in the hands of the engineering profession. By increased activity in civic affairs and educational effort the general public must be converted. A start has been made by certain organizations —the work must continue—and it deserves the unqualified support of the entire profession.

Results of Two 24-Hour Tests of Two Riensch—Wurl Sewage Screens at Dyckman Street, Manhattan, New York

To the Editor:

You may be interested in the results of two 24-hour tests made in cooperation with the Department of Public Works of the Borough of Manhattan (represented by Mr. C. E. Gregory, Engineer of Drainage and Sewage Disposal) of the two Reinsch Wurl screens for sewage recently installed at Dyckman street. The test data follow:

	Screen No. 1	Screen No. 2
Width of Slot	3-64 in.	1-16 in.
Speed	0.5 R.P.M.	0.426 R.P.M.
Day of Week	Mon.-Tues.	Wed.-Thurs.
Flow	1,687,700 Gal.	1,554,500 Gal.
Raw Sewage—		
Suspended Matter	137 P.P.M.	122 P.P.M.
Settleable Solids	100 P.P.M.	78 P.P.M.
Screened Sewage—		
Suspended Matter	101 P.P.M.	102 P.P.M.
Settleable Solids	64 P.P.M.	58 P.P.M.
Removed by Screen—		
Suspended Matter	36 P.P.M.	20 P.P.M.
Settleable Solids	36 P.P.M.	20 P.P.M.
Screenings—		
Moisture	78.5%	81.7%
Dry Material	21.5%	18.3%
Ash (Dry Basis)	14.1%	9.1%
Volatile Matter	85.9%	91.9%
Volume	38.32 Cu. Ft.	25.88 Cu. Ft.
Volume per Mg.	22.7 Cu. Ft.	16.65 Cu. Ft.
Weight	2,132 Lbs.	1,443 Lbs.
Weight, per Mg.	1,264 Lbs.	928 Lbs.
Weight, per Cu. Ft.	55.6 Lbs.	55.8 Lbs.
Removal of Suspended Matter	26.3%	16.4%
Removal of Settleable Solids	36.0%	19.6%

There was a short sharp, shower between 12 and 12:30 P. M. on June 9th but this does not appear to have had a marked effect on the day's run.

Other shorter tests confirmed the superiority of the 3/64-in. slot over the 1/16-in. size for this sewage. Also, that the screenings generally contained about 80 per cent moisture and weighed about 55 lbs. per cu. ft. It will be noted that the quality of the screened sewage in the two tests was not very different.

The loss of head was about 0.25 ft. with the 3/64-in. screen and but a tenth of that with the 1/16-in. screen but this small loss was no doubt due in part to the fact that the flow was only one-third of the screen capacity.

Kenneth Allen,

Municipal Bldg., New York, July 29, 1919. Sanitary Engineer.

Procedure in Making Tests of Effect of Motor Truck Traffic on Road Surfaces

By A. T. Goldbeck, Acting Chief, Division of Tests Bureau of Public Roads, Washington, D. C.

In view of the present uncertainty regarding the manner of procedure in the design of high types of road surfaces to withstand heavy truck traffic, the Bureau of Public Roads and Rural Engineering has started several series of investigations to determine: (1) the amount of impact delivered to roads and, (2) the effect of this impact upon different types of road surfaces. Having determined the amount of the impact delivered by trucks of different sizes the same impact will be delivered to specially constructed road slabs with the idea of determining how much impact different types of road surfacing will withstand before failure takes place.

The manner of procedure in determining the amount of impact is to allow trucks of different sizes and weights, fitted whenever possible with both solid and pneumatic tires, to drop on a plunger fitted in a hydraulic jack. The blow of the impact is delivered to a specially prepared copper cylinder and this cylinder is deformed a definite amount depending upon the impact. Similar cylinders are tested under static loads in order to see how much static load deforms the cylinder the same amount that it is deformed by impact.

In order to determine the effect of this impact on high types of road surfacing a large number of slabs have been constructed: (a) on a soft subgrade and, (b) on a well drained subgrade. A machine has been built designed to approximate the conditions on the rear wheel of a truck. This machine consists of a weight approximating the unsprung weight of the truck and supporting on a large spring another weight designed to approximate the sprung portion of the weight of the truck. These weights are allowed to fall repeatedly on the center of the slab until failure ensues. The impact required to break the slab to an amount which would make it a practical failure will be determined.

It is the idea to fit motor trucks with a special device to determine the roughness of different road surfacings so that the amount of impact delivered to the surfacings may be determined. Using the above outlined series of tests as a basis it should then be possible to state how much impact or what volume of certain classes of traffic a road of a predetermined type of surfacing will be able to carry when the subgrade is of a definite character. In other words, the whole idea is to gain sufficient data to permit of the design of high types of road surfacings to withstand heavy truck traffic.

The Selection and Use of County Road Machinery

By J. R. Johnson, Division Engineer, Kentucky Department of Public Works, Pineville, Ky.

The development of road machinery has enabled us to meet the demands of the times, said Mr. Johnson in his address during Road Builders' Week at the University of Kentucky. Road machinery is a development, not a discovery. During the past four decades the advance from hand-tools to the modern road machinery has been rapid. The law establishing the labor system for maintaining public highways in Illinois, enacted in 1879 enumerates the various implements that overseers may require to be furnished as follows: spades, shovels, axes, hoes, plows and a yoke of oxen or a team of horses or mules. This indicates about the equipment which at that time was deemed necessary for highway work. Compare this primitive equipment with the elaborate machinery used today and you will find an explanation of the great superiority of present day roads.

Use Care in Selecting Equipment

One of the first steps to be taken by a county entering upon road construction should be to supply itself with an outfit of machinery adapted to its especial needs and conditions.

The selection of machinery of this kind is attended by many difficulties; pictures in catalogues can be made extremely alluring and traveling representatives of manufacturing houses are often equipped to outrival Demosthenes in tricks of persuasive oratory. Members of fiscal courts are often not versed in the subject and are in danger of falling easy prey to artful salesmen. We must, therefore, not accept without reservation the claims made for certain machinery and for some so-called modern improvements. When we are told, for instance, that a certain machine will send all the drag and wheeled scrapers to the junk pile, we should not exert undue haste in disposing of these useful articles.

However, it is hard to overestimate the value of the modern machines. Take away all the machinery made especially for road construction and our present enthusiasm would suffer a serious abatement. A proposed construction that looks almost impossible when contemplated from a pick and shovel viewpoint, becomes easy when the steam shovel begins to walk through earth, stumps, roots and rocks in its superhuman march over the road which it makes as it goes.

Since the value of machinery is universally recognized, and since its selection is so important, any county runs much risk in leaving purchase to inexperienced men; the necessity for the advice of trained experts in this, as in other lines of big business, is apparent.

I would, therefore, suggest that before any money is expended, each county contemplating road construction or improvement should provide itself with a duly qualified engineer, who shall be competent to advise the fiscal court in the expenditure of its money as well as to supervise and direct the location and construction of its roads. He, to my mind, is by far the most important and valuable of all road machines; he is the head of the system, the dynamo which will furnish power and direction to all subsidiary machinery. His wise advice will prevent disastrous mistakes and useless waste of the taxpayers' money.

Factors Influencing Selection of Equipment

The purchaser of equipment for a given county must be governed: First, by the kind and amount of road to be constructed or repaired; second, by the availability of contractors and, third, by the ability of the county to pay for it. While it is not likely that the fiscal court of any county and the fiscal court succeeding it in office would recommend or select anything like the same equipment for the county, I have confidence enough in the engineering profession to assure me that two competent engineers would select practically the same outfit.

Let us consider two counties, side by side, and as nearly identical as possible in the amount of road already built and in their requirements for the future. The first has a good working organization that has been handed down from one fiscal court to another, while in the other, the roads have always been constructed and maintained by the brothers and cousins of its squires and the grandchildren and nephews of the county judges. The first county will need a good machinery outfit, while the other needs absolutely nothing but a pen and ink with which to sign contracts till its citizens become capable of self-government.

In discussing county road machinery at this time, I take it that the most important phase of the subject is county owned machinery. How much and what kind of road building equipment should this county or that county own? And I feel that I am justified in omitting from consideration special equipment for concrete, brick, asphalt and wood block roads since these are not much in evidence in our state.

Contract Method Favored

The machinery outfit for any county should include apparatus for a moderate amount of construction as well as adequate equipment for maintenance; the latter being of far more importance than the former. As a rule, original construction should be done by contract. The less in force account work by counties is far in excess of a reasonable profit for a contractor. As evidence of the economy of contract work, we note that most railroad construction is done in this way. Since most of the machinery needed for construction is the same as that needed for maintenance, little in addition to good maintenance equipment will be needed for a moderate amount of construction.

Counties that have progressed properly in road building need little advice in the purchase of machinery, since they have learned to entrust such matters to the judgment of experts. In discussing this subject, I therefore have in mind constantly those counties in which road construction is in its infancy.

Influence of Local Conditions

The necessities vary widely in different sections and are controlled almost entirely by local conditions. It is therefore difficult, I might say, impossible, to prescribe machinery equipment that would be equally useful everywhere.

Graded Earth Roads

Counties having graded earth roads only should be liberally supplied with small tools—plows, dragscrapers and wheeled scrapers, one ditching plow, one heavy grader, one light grader, one 10-ton roller, one 3-way drag and a single drag for each 6 to 10 miles of road in the county. While the roller is not essential for earth roads it is very valuable in compacting new construction as well as on roads where considerable repair work has been done. If one of the two graders is to be dispensed with, it should be the light one. In the most progressive counties, where earth roads are oiled, an oil-sprinkling wagon would be necessary. The county engineer who fails to demonstrate in his county the best methods of maintaining earth roads is not worthy of the name, and to do this, he must have the proper outfit for maintenance.

Waterbound Macadam Roads

Since all counties will have some earth roads to construct and maintain, those having waterbound macadam roads chiefly will need the same equipment as those having earth roads only. For these counties we should add to the above list a sprinkling wagon of 300 to 500 gals. capacity, a scarifier or a scarifier attachment for either the grader or the roller. If the financial conditions permit, it is desirable to have two rollers instead of one, a few 2-ton dump wagons and one or two motor trucks of 2 to 3-ton capacity. Where available material for macadam surface is to be found a complete quarry and crusher plant should be provided. This may be portable or stationary, depending upon the distribution of the stone in the county. It is well to have the facilities for the transportation of stone from crusher to the road, divided between wagons and trucks, as it is sometimes advisable to use one and sometimes the other, and when necessary both can be used together.

Gravel Roads

Counties having gravel roads will need the same equipment as those having waterbound macadam, except that the quarry outfit would need to be replaced by a gravel screening plant. In the construction of gravel roads the practice all too general has been to take the gravel just as it was found in the pit, without any screening, and use it for surfacing the road. One objection to this procedure is that too much sand often occurs in the gravel, to give the road surface good wearing qualities. A second objection is that where gravel deposits carrying any considerable amount of large pebbles are put on the road without screening, the large pebbles are found showing through the surface of the road after a little wear; these are soon loosened by the traffic and the result is that the road soon begins to deteriorate.

Bituminous-Bound Roads

A county having bituminous-bound roads of any descrip-

tion will need all the tools and machinery heretofore suggested. In addition, I should recommend only the appliances necessary for maintenance, because it is even more desirable that roads of this type should be originally constructed by contract, than those of simpler construction. For the maintenance we would need a 500 gal. pressure road oiler, suitable for either hot or cold application, a rotary road-sweeper, suitable boiler for heating a tank car and a heating kettle on wheels.

In addition to the plants already outlined, many pieces of machinery may be needed in road construction which have not been mentioned and which under some circumstances should be owned by the county. A steam shovel is a great time and money saver where it can be used to advantage. A concrete mixer is very desirable where there is enough concrete work to warrant its use. Under ordinary circumstances, however, these machines can be leased or worked by contract rather than be owned by the county. Many appliances not designed particularly for road construction are used for special purposes, but need not be given a place in the discussion of road machinery.

The Care of Machinery

I would feel that I had neglected a very important phase of this subject if I did not say something about the care of the machinery after it has been selected, purchased and used. It is the duty of the county road engineer to care for the machinery and tools belonging to the county, as witnessed by Section 49, Chapter 80, Acts of 1914, part of which reads as follows: "All road machinery shall be under the care of the county road engineer, and shall be cared for by him, at the expense of the county to which they belong. He shall cause to be made annually a written inventory of all such machinery, tools and implements, indicating each article and the value thereof; also the necessary cost of repairs thereto and deliver the same to the County Clerk of the county on or before October 1st, in each year, and shall, at the same time, cause to be filed with the County Clerk his written recommendation as to what machinery and implements should be purchased for the use of the county, and the probable cost thereof; he shall provide a proper place or places for housing and storing all machinery and tools, and implements owned by the county and cause the same to be stored therein when not in use." In this connection, a very urgent duty of the custodian of the county's equipment is to keep it in repair. Nothing more strongly proclaims the worthlessness of a county engineer than the fact that his machinery is not kept in repair.

Instructions Governing the Sampling and Inspection of Road Making Materials in New Jersey

Instructions governing the sampling and inspection of road-making materials for the guidance of the inspectors of the New Jersey State Highway Department were recently prepared by Wm. G. Thompson, State Highway Engineer, and are given herewith:

Whenever an inspector is assigned to a job, he will notify the laboratory at once, giving his name, official title, present address, name, location and type of pavement or road, name of contractor, name of resident, county or division engineer under whose jurisdiction the work is to be performed. The inspector will secure as soon as possible from the contractor the source and location of the various materials that will be used. He will notify the laboratory at once, giving the source and location of such supplies. When the materials are purchased from a producer, give name and address of said producer, method of shipment, and source of supply; when produced by the contractor, give location of pit or quarry and method of shipment.

Inspector's Equipment—Each inspector will be furnished with report blanks, stationery, sample bags, shipping tags, and the apparatus needed to make the field tests required. The inspector shall secure this equipment before any pavement has been constructed. This equipment is charged to the inspector, who is responsible for its proper care and return to the laboratory when the work is completed. Equipment that is lost, injured or broken, will have to be replaced at the inspector's expense, unless the inspector is in no way responsible for said loss or damage.

Size of Samples Required—The size of the first samples sent of each material shall be as follows:

Portland cement—½ of a large sample bag full.
Sand—2/3 of a large sample bag full.
Stone or gravel—1 large sample bag full.
Brick or asphalt block—15 bricks or blocks.
Granite block—2 blocks.
Fillers for bituminous pavements—½ small sample bag full.
Bituminous cements—1 quart can full.
Liquefier—1 gal. can.

The size of all subsequent samples of these materials shall be as follows:

Portland cement—2/3 of small sample bag full.
Sand—2/3 of small sample bag full.
Stone or gravel—1 small sample bag full.
Brick or asphalt block—1 block of each.
Granite block—1 block of each grade.
Fillers for bituminous pavements—½ of small sample bag full.
Bituminous cement—1 pint can.
Bituminous pavement samples—8 to 10 in. square.

Note—No samples need be forwarded of materials used in macadam or gravel pavements unless the inspector is in doubt whether these materials meet the requirements of the specifications, in which case samples of same should be forwarded in the usual manner.

Samples of Raw Materials Required Before Construction Starts—Samples of such materials as the inspector has to sample shall be secured before shipment if possible, otherwise sampled at once when the material arrives at its shipping destination.

Whether a material has been previously sampled or not, a sample shall be taken from the first shipment of all Portland cement, sand, stone, gravel, bituminous cement, fillers and paving blocks and forwarded to the laboratory. Duplicate samples of sand, stone or gravel shall be taken at the same time and kept by the inspector for reference until the work is completed.

Samples Required During Construction

Portland Cement—A sample shall be taken and forwarded to the laboratory of each car received, and the cement represented by the sample not approved for use until a report is received from the laboratory permitting its use, unless the said material has been previously sampled at the point of shipment or manufacture by the laboratory force. When thus sampled by the laboratory, the inspector shall examine the car and see that the seal is intact, but no approval shall be given by him for the use of this material until a report has been received from the laboratory permitting its use. He will, however, report to the laboratory at once the arrival of all cars thus sealed. The seal used on all cars thus sampled will be marked with a lead seal, bearing the inscription, "N. J. S. R. Com." The entire sample should be taken from one bag usually near one end of the car. It is well, however, to occasionally take the sample near the car doors.

Sand, Stone and Gravel—The inspector shall compare each consignment of sand, stone and gravel with the first approved sample. In case any of these materials do not appear to be of as good character or quality as the first sample approved, and the results of the field test subsequently made indicate

it is of inferior quality, a sample shall be taken and forwarded to the laboratory at once. A regular sample shall be taken from every 10 or 15 cars of sand received and forwarded to the laboratory regardless of its quality or character.

If the consignment to be sampled is of uniform appearance and grading throughout, one sample may be taken to represent the entire shipment. This sample shall be taken at various points and mixed by rolling on newspapers or canvas. After thorough mixing and so manipulating the paper as to bring the material to an evenly rounded pile, take one-fourth of the sample and with this proceed as before until the quarter last taken is of the proper size for tests. If the consignment to be sampled is not uniform in appearance, then a complete sample must be taken and tested from each grade contained in the shipment.

Paving Block—Samples of paving block shall be taken during construction only when the quality does not appear to be as good as that of the approved sample, in which case a single block will be mailed to the laboratory for examination.

Bituminous Cement—A sample shall be taken from each carload received and forwarded to the laboratory at once, and the material represented by the sample not approved for use until a report is received from the laboratory permitting its use, unless the material has been previously sampled at the point of shipment or manufacture by the laboratory force. When thus sampled by the laboratory the inspector shall examine the car and see that the seal is intact, but no approval shall be given by him for the use of this material until a report has been received from the laboratory permitting its use. He will, however, report to the laboratory at once the arrival of all cars thus sealed. The seal used on all cars thus sampled will be marked with a lead seal bearing the inscription, "N. J. S. R. Com."

When shipment is made in tank cars, the sample should not be taken until the material in the car has been heated and agitated sufficient to make it uniform in composition. If shipment is made in box cars, a sample must be taken from each lot or batch present as indicated by the batch or lot numbers on the head of the drums or barrels. Additional samples must be taken during the use of all bituminous material whenever the inspector has any reason to believe the cement is not of normal consistency or of an inferior quality as may be indicated by the general appearance of the paving mixture or pavement constructed therefrom.

Bituminous Pavement Samples—A pavement sample shall be taken of the pavement completed each day, such as warrenite, topeka, amiesite, sheet asphalt, etc. This sample shall be about 8 in. to 10 in. square and shall not be taken until the pavement has received its final rolling, but should be cut out before the pavement has chilled when it belongs to the hot-mixed type. In case a squeegee coat is required, a place shall be left unsqueegeed and the sample taken at this point.

The inspector at the mixing plant will sample, examine or test, in the matter herein designated, all materials used in preparing the pavement, keep a record of batches prepared each day, the number of loads delivered to the street or road, take the temperature of each load and note the general appearance and character of the paving mixture, also see that the asphalt cement or mineral aggregate is not heated above the limits permitted by the specifications. The maximum and minimum temperatures to which these materials were heated should be recorded and reported each day. Whenever a definite weight of paving material has to be used per square yard of surface pavement, the inspector at the plant will also keep a record of the weight of materials used therein. When materials come from a local sand or gravel pit, the quantity received per day of each shall be roughly estimated.

Paving mixtures that are improperly mixed, have been overheated, or do not have the minimum temperature required by the specifications, or are deficient in asphalt cement or filler, shall be condemned at the mixing plant and the inspector on the road notified to this effect.

The inspector on the road or street will keep a record of each load of paving material received, take its temperature, note its general appearance and report the total number of loads received each day, also observe whether the mixture is of proper consistency to be easily handled when dumped, observe how it consolidates during rolling and note the rapidity with which the rolling is executed after the material has been spread, also whether the rolling is continued until no further evidence of compression is evident. When mixtures are received that do not have the required temperature, are not fairly uniform in composition, or show evidence of careless preparation at the mixing plant, they shall be rejected as soon as the material is dumped and before it has been spread on the road. Special care must be taken to see that no depressions or waves are formed during rolling.

In additon, the foundation should be very carefully examined as the pavement is being spread, and any places that appear to not have the proper density or stability, or appear to be improperly drained, or have been recently rebuilt should be recorded on the daily report blanks. All such reports should be indicated by both the station number and land marks. The pavement samples shall also be taken and forwarded by the inspector on the road. The location of each sample shall be designated by the station number and also a land mark whenever possible.

When bituminous mixtures are purchased by the ton ready for use, the weight of each load shall be taken and recorded by the inspector on the road in addition to the other requirements specified above, and the total quantity received each day recorded.

Concrete Test Cubes—A 6-in. cube shall be made for each 1,000 sq. yds. of finished concrete surface or foundation, and for each 150 cu. yd. of concrete used in retaining walls, bridge abutments, etc. They shall be taken at proper intervals to space them at approximately equal distances apart. An additional cube shall be made whenever a mix appears to be unusual in any respect, such as exceedingly wet, improperly mixed, etc. In making the cubes, the inspector will proceed as follows:

See that the equipment is in proper order. The mold should be set on base and leveled carefully. See that it is securely fastened together and that inside surface is thoroughly coated with oil (either heavy lubricating or light cylinder is good).

Fill the mold full of concrete and puddle thoroughly with a steel rod ¼ in. to ½ in. in diameter. The greater part of puddling should be done around the outer edge near the sides of the mold, being careful not to scar the inside surface of mold when pushing rod down into concrete. When properly puddled the cube will be practically free of voids. After puddling fill mold to top again and trowel smooth and level with top of mold.

Place a piece of board or heavy canvas over top to keep off rain or hot sun.

About 24 hours after making, remove mold and mark plainly on side of cube sample number and date made. The inspector will then immediately clean and oil the mold for the next fill.

Place the cube in water and leave it there for six days, after which remove cube from water, wrap in wet newspapers, place inside container and ship to the laboratory.

The same inspector shall make the cubes in all cases to insure uniformity of tamping and other conditions.

It is essential that the above rules be closely followed to insure uniform conditions in making, storing and shipping; otherwise, the concrete cube is worthless for testing purposes.

Forwarding and Reporting Materials—Samples forwarded either before or during construction must be numbered and plainly marked with the name of the material, road, route or

job, and the inspector who forwarded same. All samples forwarded of each material must be numbered consecutively, i. e., Portland cement would be marked 1, 2, 3, etc.; bituminous cement, 1, 2, 3, etc.; pavement samples, 1-P, 2-P, 3-P, etc., unless more than one pavement sample is taken of the pavement laid during any one day, in which case both samples will have the same general number but given different index numbers, thus, 7-P^1 and 7-P^2 would indicate that both samples were taken from the pavement laid during one day. Whenever paving-mixture samples are forwarded, they shall be marked 1-M, 2-M, etc., if the pavement is laid in one course only; if laid in two courses, they should be numbered 1-BM, 2-BM, for bottom-course samples, and 1-TM and 2-TM for top-course samples.

A separate report must be mailed at once to the laboratory of each consignment of samples sent. This report must be made out on the blank forms furnished therefor and must be filled out in the manner indicated thereon. The samples shall be designated in this report in the same manner as they are marked on the shipping tag, or, in other words, both reports must agree. The written reports must give the location of source of supply of the material, quantity represented by sample, and the purpose for which the material is intended to be used. Also state from where the sample was taken, and, if a special sample, state why it was taken; if taken from a car, the name, number and location of car shall also be given. The location of all pavement samples and date when laid and taken shall also be given. The location of all concrete represented by the cubes forwarded, date cube was made, and proportions of mixture used therein must be definitely stated in the written report.

A daily report must be sent to the laboratory during the actual construction of all bituminous, Portland cement or block pavements. In case work is suspended for any cause, the last report will designate why the work was stopped and when work will be resumed.

Field Tests

Field tests shall be made on the following materials in the manner designated herein below as soon as each shipment is received.

Concrete Sand—The sample taken shall be carefully compared with the first sample taken by the inspector and which has been previously approved by the laboratory. After thoroughly mixing, a portion shall be selected to test for organic matter by the colorimetric method described below. The balance of the samples shall be spread out in a thin layer on a paper or piece of canvas, so that it will dry quickly. After the sample has thoroughly dried, it shall then be compared with the inspector's sample. Colorimetric tests shall be made on concrete sands only.

Colorimetric Tests—Fill graduated bottle to 4½ oz. mark with sand; then fill to 7 oz. mark with sodium hydroxide solution (see directions for preparations in equipment case); shake thoroughly and fill again with solution to the 7 oz. mark; set bottle where it will not be disturbed and shake well several times after filling at intervals of two or three hours. From 20 to 24 hours after filling, compare the color of solution in test bottle with a standard furnished with equipment (see directions in case). In case the solution in the test bottle has developed a darker color than that in the sample bottle, no permit should be issued for the sand represented by this sample. The sample should then be taken and forwarded to the laboratory and a report made in the manner above designated.

Whenever a sieve analysis is required of a concrete sand, proceed in the same manner as specified therefore under "Bituminous Sands."

Bituminous Sands—Bituminous sands shall be sampled and compared with the inspector's sample in the same manner as specified for concrete sands. The dried sample shall be sieved as herein specified, and the results secured compared with the analyses made by the laboratory on the first sample. Samples taken from the hopper by an asphalt plant shall be quartered and sieved in the same manner as specified for a sand.

Sieve Analyses—A 200 or 300 gram sample of the dry sand shall be selected in such a manner that it represents the average composition of the sand dried. The bottom pan shall be then attached to the ¼-mesh sieve and the weighed sample poured into this sieve. The sieve shall then be shaken until practically no more material can be made to pass this size sieve. The material retained on the sieve shall then be weighed, the weight recorded and this material discarded.

The material which has collected in the bottom pan shall be transferred to one of the weighing pans or onto a clean paper, the bottom pan adjusted to the next size sieve (10-mesh), the unweighed portion of the sample transferred to this sieve and shaken until practically no more material passes this sieve. The material retained on this sieve is then weighed in the same manner as before and the operation repeated for each of the various size sieves, using next largest sieve in each case. The material that is finally secured in the bottom pan will be that passing a 200-mesh sieve. The weights secured for the material retained on each sieve should be divided by two if a 200-gram sample is used, or three if a 300-gram sample is used, which will give the per cent. of the various sizes of the sand grains contained in the sample.

It is not expected that the results thus secured should agree with the analyses made by the laboratory on the first sample approved, but should not show a variation of over 3 per cent. above or below that reported by the laboratory for the material retained on any one given sieve.

Stone, Gravel or Other Coarse Aggregate—In addition to general appearance examination to determine whether the quality compares with that of approved sample, the sizes of coarse aggregate must be checked from time to time with the larger sieves having circular openings. With these sieves, proceed as in sieve analyses of sand, except, of course, it will be necessary to use a larger sample.

Portland Cement—There is no field test for Portland cement, except that in cases where the original container has been wet, or, for any other reason, the material contained therein has become hard and lumpy, no permit will be issued for cement of this character.

Bituminous Cement—The only field test to be made on bituminous cement is to check up the consistency, or, in other words, determine the penetration the material has at 25°C. (77°F.). To make this test a 3-oz. can is filled nearly full of hot asphalt cement. When cooled to nearly normal temperature, it should be set in a pan containing sufficient water to completely cover the can. This water should be kept at 25°C. for about one hour. The specimen is then removed from the water and placed on the platform of the penetration machine. The needle is then adjusted so its point just touches the surface of the asphalt cement and the plunger released for a period of five seconds. The readings on the dial, which was previously set at zero, will show the distance in millimeters, the needle penetrated. This shows the consistency of the asphalt cement and should agree with the limits defined therefor in the specifications.

Bituminous Pavement Samples—All pavement samples cut should be carefully examined to see if they have the thickness and density required by the specifications. If the paving mixture was at normal temperature when spread (about 300°F.) the general appearance of a clevage face of the pavement will give a fair idea whether the bituminous content is correct or not. No other field tests are required on pavement samples.

Bituminous Mixtures—The temperature of these mixtures should be taken and general appearance when dumped into the wagon observed. If the mixture is at normal temperature (about 300°F.), it should have a bright and lively appearance if it contains the required quantity of asphalt cement. If it

is deficient in asphalt cement, it will have a dull color, being more plastic and stiffer than a mixture containing the required quantity of asphalt cement. When a mixture is too rich in asphalt cement, it will be very soft and sloppy.

The paper-pat test is a more reliable method of determining the asphalt content of a paving mixture in the field than to judge the asphalt content of these mixtures by their general appearance. The test is made in the following manner:

Bituminous Paper-Pat Test—To make a pat-paper test, a small quantity of the bituminous mixture (about 200 grams), having a temperature of about 300°, is placed on one-half of the pat-paper and the other half turned over on the top of the mixtures and gently tapped down thereon three or four times with a small wooden block or paddle until the bituminous mixture has a thickness of about ½-in. The paper should also rest on a wooden board or block in order that the paving mixtures will not cool quickly. The top paper is then gently pulled away from the bituminous mixture. If the mixture is deficient in asphalt cement, very little stain will appear on the paper; if too rich in asphalt cement, a decisive coating will be left on the paper; if the per cent. of asphalt cement is about right in the paving mixture, a distinct impression will be left on the paper, but not enough to make a coating.

This test should never be made on a mixture that has a temperature less than 275° or over 325°F., otherwise the asphalt stain on the paper is of little value in determining whether the mixture contains the right amount of asphalt cement or not.

Recommended Method of Resurfacing an Old Macadam Road That Is Filled with Ruts and Holes

By William N. Bosler, Division Engineer, Department of Public Roads, Frankfort, Ky.

Perhaps the most general and perplexing problem met with today by highway engineers in Central Kentucky, is the resurfacing, economically, of an existing waterbound macadam road that is filled with ruts and holes.

No matter how well macadam roads were constructed in the past, they will not stand under our present day traffic conditions. It is true that maintenance is economy, and the patrol system will prolong the life of waterbound macadam roads, but generally speaking every third season resurfacing is required.

The condition most frequently met in practice is the road surface filled with ruts and pot holes, or the surface entirely worn off, which has been caused through internal wear, lack of sub-drainage, ditching or inferior grade of stone.

The Telford Road

In Central Kentucky two types of macadam roads are met with, namely, the old Telford road and the waterbound macadam road, and these will be treated in the order named.

Years ago, when materials and labor were cheap, slaves were used in laying this Telford type of construction. Today we find the cross section of this same Telford road distorted almost beyond recognition and with practically no metal covering remaining. The road in question may be dished in the middle, concave in sections, the edges of the Telford being as much as 6 or 8 ins. higher than at the center. Again we find the Telford wholly exposed with practically a flat or very little slope to the cross section remaining. This undoubtedly is due to inadequate sub-drainage or improper foundation and not to original design.

Being confronted with these conditions, and a limited road fund at hand, the road engineer is up against a tough proposition. In some rare instances it might pay for him to salvage the remaining Telford, crush it with his portable crushing outfit, and use the stone thus derived in constructing a new waterbound macadam road. However, it is generally conceded that such a road would not be the equal of a resurfaced macadam on this existing Telford foundation. Owing to the present cost of labor it would be prohibitive, in price, to attempt to re-lay the existing Telford to its original cross section and then resurface as waterbound macadam. As a solution to this problem, it is the writer's opinion, that the old Telford foundation should be left undisturbed except where it is above the new established grade and cross section, and a filling of creek gravel properly placed and spread on the old distorted Telford. The builder should add enough gravel to produce a true cross section to the sub-base course, then it should be properly spread and rolled with a 10-ton roller, allowance being made for sub-soil and blind drainage where necessary. Most localities have an abundance of good grade creek gravel, consisting of sand and gravel, which could be secured within reasonable hauling distance and thus reduce the cost of preparing the sub-base.

The next operation consists in spreading and rolling, on the sub-base just prepared, crushed stone not to exceed 5 ins., compacted measurement. After this screenings are spread and rolled, watered and re-rolled until the surface is properly bound as a waterbound macadam road surface.

The spreading and rolling and watering of crushed stone and screenings on this type of resurface work is just as important and should be done in the same way as in constructing an original waterbound macadam road. In some exceptional cases a small amount of surfacing metal is still remaining as a covering on the Telford foundation. However, it is too thin to bear consideration and if the Telford is true or nearly true to cross section our best plan is not to disturb the existing metal or Telford, but simply to add crushed stone not to exceed 5 ins., compacted measurement, spread properly, rolled thoroughly, apply screenings, water and bond as a waterbound macadam road.

So much for the Telford type of construction. We will now consider the ordinary waterbound macadam road that has begun to deteriorate.

The Waterbound Macadam Road

As in all branches of engineering pertaining to reconstruction work, our first duty is to ascertain what the existing structure, in this case the macadam road, consists of; how much metal remains and in what condition it is. This information cannot be obtained entirely by a mere surface inspection, but requires digging into the old road metal. It is true we can see at a glance where the grade has been disturbed, where the cross section has been destroyed, but to arrive at the amount of metal remaining in the road it is absolutely necessary to make test holes or test trenches. Either method will procure information. However the trench method, that is, digging a trench say, 12 ins. wide to the full depth of metal, across the entire road, at right angles with the center line of the road, gives the best results. These test trenches should be taken every hundred feet or so, depending upon the general condition of the road. This will enable one to see just where the road has worn and how much.

Having arrived at the conclusion of how much metal remains and in what condition it is, the next duty is to establish an economic grade line. Bearing in mind that most any practical road builder can construct a road with 12 ins. or more of stone, it is the road engineer's job to determine what will be a sufficient amount of metal to add, and no more, to insure thorough bonding with the existing metal and produce a good road surface. Most authorities agree that 7 ins. of compacted crushed stone is ample for any waterbound macadam road. In other words, there is a limit beyond which depth of stone in resurfacing work is too expensive for results obtained, and beyond that limit it is better and cheaper to surface or otherwise resurface the road in question.

Now having determined the amount and condition of existing road metal and having established an economic grade

line, it is our duty to salvage or prepare existing road metal for the new stone. As an illustration, say the road in question has 3 ins. or less of compacted metal remaining and is filled with ruts and holes. In that event it is practically useless to scarify it, as scarifying would tend to destroy the bonded metal already in place and would not help our cause any. Oftentimes scarifying is misused, as a result you disturb what structure you had to start with, and in the end you are endeavoring to bond by rolling in one operation, a greater depth of metal than can be properly handled. The better plan would be carefully to fill all ruts and pot holes with clean stone well graded and thoroughly roll it. Add sufficient metal to insure 7 ins. of compacted stone, spread to true cross section, rolling it thoroughly with 10-ton roller. Add screenings, roll, dry, then wet and re-roll until the whole is thoroughly bonded and presents a smooth surface.

For next consideration, take a macadam road filled with ruts and holes that has 4 ins. or more of compacted metal, the road being distorted as to cross section. Our first operation is to fill the holes and ruts in question with new metal, then spike and scarify the road. After which harrow and grade the existing metal to the true cross section and roll thoroughly with 10-ton roller. Now add sufficient new stone to insure 7 ins. of compacted metal, considering the amount of stone already in the road. Spread and roll with 10-ton roller, add sufficient screenings, roll it dry, then wet and re-roll until the whole is completely bonded and presents a smooth surface.

In some cases one might find a macadam road of 7 ins., or more, compacted metal that is filled with holes and ruts, but has retained its cross section approximately and is true to line and grade. In that event it is the writer's opinion that it is useless and expensive to add an arbitrary amount of new stone. The proper course to pursue would be to fill the holes and ruts with well-graded crushed stone. Spike, scarify, and harrow them, adding just sufficient new metal to bring the road to its proper cross section after shaping. Roll thoroughly with 10-ton roller, applying sufficient screenings which when properly wet and rolled will bond thoroughly and produce a smooth surface.

In this day of inadequate road funds a road engineer that can work existing macadam road that is filled with ruts and holes, utilizing every ton of stone remaining in it, and adding just as little new stone as is absolutely necessary to produce a well-bonded road of smooth surface, has indeed accomplished something that is a credit to himself and his county.

Resurfacing or reconstruction of waterbound macadam roads, under present day traffic conditions, presents problems worthy of the attention of highway engineers. These problems are of vast importance, and should be given more earnest consideration than they have received in the past if we wish to make our road funds cover a greater mileage.

Acknowledgment

The foregoing paper was presented during the recent Road Builders' Week held at the University of Kentucky.

Seventeenth Annual Convention of the American Road Builders' Association

The seventeenth annual convention of the American Road Builders' Association will be held at Louisville, Ky., on Feb. 9, 10, 11, 12 and 13, 1920.

In connection with this meeting of the Association, which will be the Tenth American Good Roads Congress under the auspices of the A. R. B. A., there will also be held the Eleventh National Good Roads Show. At the 1918 and 1919 meetings the show feature of the congress was confined to small exhibits that could be accommodated in the hotels in which the meetings were held. The conditions which led to the adoption of this plan no longer existing, it is proposed to make the 1920 show similar to the complete exhibits that were held previous to 1918. Moreover, because of the re-awakened interest in road building and the enormous expenditures which are going to be made in the next few years, the officials of the association expect to get together an exhibition that will surpass even those of former years.

The decision to accept the invitation extended by the city of Louisville was reached at a meeting of the board of directors at which invitations from many other cities were considered. It was felt that Louisville, because its central location and its accessibility from all parts of the country would meet the requirements of the 1920 convention better than almost any other city. In addition, the 1919 convention was held in New York, and it was felt that the national character of the association compelled the holding of next year's meeting farther west.

Both the sessions of the convention and the exhibition will be accommodated in the First Regiment Armory. About 53,000 sq. ft. of floor space will be available and plans of the exhibition hall will be prepared and issued in the near future. As the armory is situated within two or three blocks of the leading hotels of the city, the officials of the association feel that the facilities of the meeting are very nearly ideal.

The program, as in years past, will cover every phase of highway construction and maintenance and various related subjects. The prepared papers and the discussions will deal with highway problems from the points of view of road and street officials, highway engineers, contractors, and all of the various classes actively engaged in highway work.

At no previous time in the country's history has road betterment been the subject of so great general interest as at present, nor have the expenditures for the improvement of the country's roads ever been so great as those which will be made within the next few years. During the next year there probably will be available almost a billion dollars for road and street work, and the prospects are bright for even greater expenditures in the near future. For these reasons it is believed that the Louisville convention will be the most important ever held, both in point of attendance and in the interest shown.

Results of the Test Run of the Direct Oxidation Experimental Sewage Treatment Plant at Easton, Pa.

By C. A. Emerson, Jr., Chief Engineer, Pennsylvania Department of Health, Harrisburg, Pa.

(Editor's Note: The present article is a report, slightly rearranged and condensed, made by Mr. Emerson to Edward Martin, Commissioner of Health for Pennsylvania, dated Jan. 28, 1919, covering a test of the "Direct Oxidation" experimental sewage treatment plant at Easton, Pa. The test was conducted under Mr. Emerson's direction by Assistant Engineers A. L. Reeder and R. B. Styer and Inspectors W. R. Crull and J. L. Sullivan. A test run of 8 hours' duration was made, starting at noon on Dec. 4, 1918, followed by a 24 hour test, starting at 8 a. m., on Dec. 6, 1918.)

General Conditions

The city of Easton, having a population of some 30,000, is located on the west bank of the Delaware River, just below the mouth of the Lehigh River. Most of the existing municipal sewers receive both storm water and sanitary sewage and provide sewerage facilities for approximately two-thirds of the total population. This city has been forbidden by the Department of Health to extend the sewer system until some adequate method of treatment is provided because of the extensive use of the Delaware River below Easton as a source of water supply for municipalities in Pennsylvania and also in New Jersey.

The city has made studies looking towards the adoption of

some form of sewage treatment, but no definite plans have as yet been adopted. In the latter part of 1917 Mr. C. P. Landreth of Philadelphia, patentee of the "Direct Oxidation Process," proposed that an experimental plant be constructed in Easton without obligation on the part of the city. Permission was granted by the city on Nov. 10, 1917, and construction of a plant having a nominal capacity of 1,000,000 gals. a day was begun on a site near the Delaware River at Front and Spring Garden streets. The plant was completed and placed in operation shortly after May 1, 1918. The Department had intended to observe the operation of the plant throughout the summer, but shortage of engineers, due to war conditions, made this impossible.

The sewage received at the experimental plant appears to be a fresh, domestic, municipal sewage of ordinary concentration and composition and passes through a centrifugal pump before treatment.

The processes of treatment used consist of

1. Coarse bar screens
2. Flat plate fine screens—(¼-in. circular openings)
3. Grit chamber
4. Chemical treatment—(3,720 lbs. lime per 1,000,000 gals.)
5. Electrolysis—(Type C electrolytic apparatus, C. P. Landreth's "Direct Oxidation Process")
6. Settlement—(4½ hours average retention horizontal-flow basins)

Tributary Sewers

The area tributary to the plant is divided into two distinct districts. The first is sewered on the separate system, contributing sanitary sewage only, while the second district contains combined sewers, contributing both storm water and sanitary sewage.

A survey of the district indicated 585 properties connected to the sewer system as follows: 511 dwellings, 37 combined stores and dwellings, 10 stores, 2 office buildings, 3 hotels, 3 schools, 1 laboratory, 7 churches, 1 armory, 8 garages and 2 breweries. The order of the Federal Government closing breweries became effective four days previous to starting the test of the plant, hence the volume of manufacturing waste discharged from these breweries was much reduced.

The rainfall during the last part of November and the few days of December preceding the test was negligible.

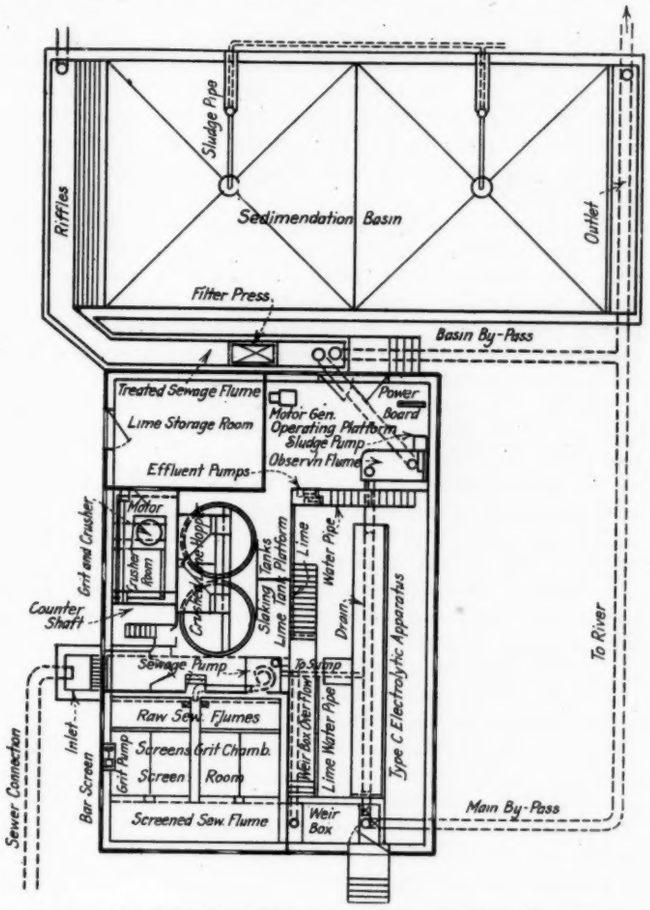
The time of passage of sewage from the most distant house in the district to the sewage treatment plant is comparatively short and probably does not exceed an hour and a quarter. The low quantity of total solids, suspended solids and oxygen consumed indicate a relatively dilute sewage; the presence in appreciable quantity of nitrates and nitrites and the ratio between the organic nitrogen and the free ammonia contents show that the sewage is quite fresh as treated at the plant.

Description of Plant

Sewage is diverted from the 3 ft. by 4 ft. 6 in. egg-shaped combined sewer in Front street through a 12-in. pipe, a concrete dam having been constructed in the main sewer immediately below the lateral. At the plant the 12-in. pipe discharges through a 10-in. valve into a covered flume 3 ft. 6 ins. wide, equipped at its inlet end with a coarse bar screen for the removal of sticks and other large objects. The flume leads to the suction well of a 6-in. centrifugal pump which lifts the sewage about 14 ft. 6 ins. to a raw sewage flume, placed at such an elevation that the sewage can flow thence by gravity through the treatment plant. From this flume the sewage flows on to a horizontal flat plate screen with closely spaced holes ¼ in. in diameter, through which it falls into a hopper-bottomed grit chamber. The raw sewage flumes, fine screens and grit chambers are in duplicate, only one-half being used at a time. The screened sewage overflows from the grit chamber into the screened sewage flume, passes over a 3 ft. weir, is treated with a suspension of lime and then passes through a 12 in. pipe to the electrolytic cell. From the cell the sewage flows through an open observation flume connected to the treated sewage flume and thence over concrete riffles into the sedimentation basins. The two basins are connected in series and have a combined capacity, to the elevation of the outlet weir, of 88,740 gals., giving when clean a detention period of about 2⅛ hours on a flow of 1,000,000 gals. per 24 hours. A 4-inch sludge pipe is provided from each basin to permit of drawing the sludge on to two small sludge-drying beds immediately east of the sedimentation basins.

The entire plant, with the exception of treated sewage flume, sedimentation basins and sludge beds, is neatly housed in a sheet iron building 48 ft. 3 ins. long and 35 ft. 6 ins. wide.

The difference in elevation between the fine screens and the overflow weir from the sedimentation basin is 5 ft.



PLAN OF EXPERIMENTAL DIRECT OXIDATION SEWAGE TREATMENT PLANT AT EASTON, PA.

By-pass arrangements permit of running screened or screened and lime-treated sewage from the weir box direct to the river, or of running treated sewage from the treated sewage flume to the river without passing through the sedimentation basins. An overflow pipe in the screened sewage flume diverts any excess over the capacity of the plant, returning it to the pump well. The low concrete dam in the main sewer permits the latter to take the entire flow when the pump is not operated or excess flow in time of storm.

Electrolytic Apparatus—The electrolytic apparatus is enclosed in a horizontal wooden tank 27 ft. 3 ins. long, 3 ft. wide and 2 ft. 9 ins. high (outside dimensions), reinforced with steel plates and mounted on supports 18 ins. high. Two 2-in. wrought iron vent pipes are carried up from the top of the tank for the removal of any excess gaseous products of electrolysis. A series of blow-out valves are provided along the bottom of the tank.

This tank contains 22 banks of plates, arranged in two

layers of 11 banks each. Each bank of electrodes consists of 48 rectangular steel plates 16 ins. long, 10 ins. high and 3/16 in. thick, placed parallel to the sides of the tank and spaced ⅜ in. apart. The plates are so connected that alternate plates have the same polarity, giving 24 pairs of plates connected in multiple in bank, the 22 banks being connected in series. Spaces between the banks and the sides of the tank are closed, compelling the sewage to flow through the ⅜ in. spaces between the plates. In each space between the plates two straight paddles of Bakelite are revolved, being attached to shafts passing through holes punched in the plates to receive them. The paddles are driven at a speed of 20 revolutions per minute by a 3 H.P. motor, the power being transmitted to the paddle shafts through suitable reduction gearing. The total number of paddles in this plant is 2,068.

At the normal rating of the plant, i. e., 1,000,000 gals. daily the time of passage through the electrolytic cell is approximately 70 seconds, of which 17.4 seconds represent the time of contact with the electrodes, the remainder of the time being occupied in passing through dead space between successive electrodes. During contact the sewage travels in streams ⅜ in. thick for a distance of 14 ft. 8 ins. at a theoretical velocity of 0.84 ft. per sec.

Lime Apparatus—Provision is made for using either lump or hydrated lime. When the former is used the lumps are broken by hand on a 3-in. grid placed over a crusher which discharges into an elevator boot. When hydrated lime is used a spout delivers it directly into the elevator boot. The elevator discharges into an overhead hopper from which it is fed dry by adjustable feeding devices to the solution tanks.

The solution tanks are two in number, each 7 ft. in diameter and 3 ft. deep, each with an independent feeding device and agitator. Only one tank is used at a time.

The feeding device consists of a trough with a double worm feed actuated by a ratchet and pawls, which is turn are driven by a reciprocating link attached to an eccentric. The rate of feeding lime to the solution tank may be adjusted within certain limits by changing the throw of the eccentric and by varying the number of teeth engaged on the ratchet by changing the position of the pawl arm.

Either city water or plant effluent can be used in the solution tanks; when the effluent is used it is pumped by a motor-driven 1-in. centrifugal pump. In either case, the water enters the tank tangentially near the bottom to help the agitation and the lime suspension or milk of lime is drawn from the top of the tank. Agitation is by means of a two-bladed 10-in. fan placed at the bottom of the tank and operated at 900 revolutions per minute by the 1-h.p. motor, which also drives the feeding device. The circulation is downward at the center and upward at the sides.

Suitable piping delivers the lime suspension into either the spillway of the weir or the observation flume, as desired.

List of Electric Motors Installed:

For initial pumpage of raw sewage..	1	7½-h.p. motor
For lime treatment:		
Lime crusher	1	5-h.p. motor
Effluent pumps	2	1-h.p. motor
Feeding and agitation	2	1-h.p. motor
For electrolytic cell:		
Paddles	1	3-h.p. motor
Electrolysis	1	5-k.w. motor-generator set
For handling grit and sludge:		
Grit pump	1	2-h.p. motor
Sludge pump	1	1-h.p. motor

Of the four 1-h.p. motors listed under lime treatment only two would be in service at a time.

Description of the Process

The process is essentially one of fine screening, followed by lime precipitation, agitation, electrolysis and sedimentation.

The screening through ¼-in. circular openings removes from the crude sewage solid particles of larger size than these openings.

The addition of the lime is claimed by the owner of the electrolytic process to be essential to that phase of the treatment of the sewage, but it should be borne in mind that chemical precipitation of sewage is one of the oldest processes known to the art and produces a very considerable removal of suspended solids.

The electrolytic action liberates nascent oxygen and hydrogen by the passage of the electric current through sewage rendered alkaline by the addition of lime. The agitation, in addition to its well-known effect in inducing precipitation, brings the sewage into intimate contact with the products of electrolysis. Chemical reaction is thereby stimulated while the gases are still in the nascent state and before they have an opportunity to escape. The paddles undoubtedly serve also mechanically to clear the plates and prevent polarization.

In normal operation the lime suspension is added to the sewage immediately before entering the electrolytic cell in order to insure positive alkalinity, a condition considered necessary for electrolysis without attack of the electrodes. There is a gradual deposit of calcium carbonate on the plates, which it is claimed can be remedied by temporarily shifting the point of application of the lime to the outlet flume leading from the electrolytic cell. The sewage, under such conditions, is said rapidly to remove the coating from the plates, permitting normal operation to be resumed in 15 or 20 minutes. A heavy deposit on the plates is indicated by a marked increase in the power required to drive the paddles. No considerable increase was noted during the period of the test.

Some polarization of the plates occurs from time to time, but this is overcome by a reversal of the polarity, which quickly decreases the necessary voltage and increases the current.

For satisfactory operation it is said that the cell effluent should contain not less than 30 parts per million of excess alkalinity. During the period of the test this content was always exceeded.

As the sewage reaches the observation flume after passage through the electrolytic cell it contains the lime and the suspended solids. The subsequent sedimentation is to permit the deposition of these materials so as to clarify the effluent and separate the sludge for treatment.

Condition of Test

The plant had been closed since about Oct. 15, 1918, and intermittent operation was again resumed on Dec. 2, only two days prior to starting the 8-hour test.

During the test the plant was operated by the company, in order that there might be no division of authority and to controvert possible criticism regarding inefficient operation. The department's representatives observed the operation of the plant, made tests on power consumption, quantity of lime used, flow of sewage, and took samples of the sewage, etc.

Prior to undertaking the test all bypass connections were closed and sealed, electric meters and water meters were read and various measurements were made of the dimensions of the units.

During the 8-hour test electric and weir readings were taken at intervals of 15 minutes and at intervals of 30 minutes during the 24-hour test. Samples of the sewage, proportional to the flow, were collected every 30 minutes during the 8-hour test and every hour during the 24-hour test. These were mixed to form composites for chemical analysis for each test run. Settleability and alkalinity samples were collected every four hours, and putrescibility, dissolved oxygen and bacteriological samples were collected every 8 hours. Lime samples were collected at irregular intervals, averaging probably 2 hours, and thoroughly mixed, forming a single sample for analysis.

The Standard Methods of Analysis of the American Public Health Association were followed at the laboratory.

The flow of sewage was determined by weir readings taken every 30 minutes during the tests, and varied from a minimum of 309,000 gals., which occurred at 2:30 a. m., to a maximum of 816,000 gals., which occurred at 11:30 a. m. The average flow during the 24-hour test was at the rate of 460,000 gals. per day, or slightly less than one-half the rated capacity of the plant.

During the 8-hour test the polarity of the electrolytic cell was changed at 3:23 p. m., in order to decrease the effects of polarization. Immediately after such change the voltage was found to be 40 and the amperage 55. During the 24-hour test a similar change was made on several occasions, but the exact hours were not noted.

At 4:20 p. m., on Dec. 6, a portable volt meter was applied to the various electrodes to determine whether the total voltage at that time was evenly distributed throughout the electrolytic cell. The results at the outlet end were as follows:

Upper Bank....2.8 2.7 2.85 2.7 2.75 2.9 2.95 2.9 3.1 3.0 3.75
Lower Bank....3.0 2.7 2.55 2.65 3.0 2.9 2.8 2.75 3.4 2.8 3.45

Immediately after the completion of the test the switchboard ammeter was compared with a portable millivoltmeter with external shunt. The two were found to agree within two or three per cent.

SUMMARY OF RESULTS

	8-hr. test	24-hr. test
Power Consumption		
Lights and Electric Heaters	11 K.W. hrs.	47 K.W. hrs.
Pump Motor	30 K.W. hrs.	90 K.W. hrs.
All other power	50 K.W. hrs.	130 K.W. hrs.
Total	91	267
Total water consumption (This includes toilet, lavatory and the stuffing boxes of the centrifugal pump.)	66 cu. ft.	166 cu. ft.
Quantity of lime	.....	1,712 lbs.
CaO content		61.52%
Average voltage for electrolysis	56.3	57.5
Average current for electrolysis, amperes	37.8	33.8
Average wattage for electrolysis	2,125	1,944
Average wattage for paddles	1,388	1,355
Sewage flow in gallons per 24 hours.	482,700	460,000
Average sewage flow in gallons per hour	20,110	19,190
Electrolytic hydrogen liberated in grams per hour	31.04	27.82
Electrolytic oxygen liberated in grams per hour	247.73	222.03
Ratio of electrolytic hydrogen to sewage by weight	0.4 p.p.m.	0.4 p.p.m.
Ratio of electrolytic oxygen to sewage by weight	3.2 p.p.m.	3.0 p.p.m.

BACTERIOLOGICAL RESULTS

Figures Represent Bacteria per c.c.

—8-Hour Test—

	Time	Raw Sewage	Screened Sewage	Cell Effluent	Basin Effluent
Total Bacteria	2:30 P. M.	800,000	200,000	38,000	2,000
B. Coli	2:30 P. M.	36,000	24,000	0	0

—24-Hour Test—

December 6—					
Total Bacteria	8:00 A. M.	920,000	680,000	24,000	65
B. Coli	8:00 A. M.	100,000	120,000	0	0
Total Bacteria	4:00 P. M.	240,000	216,000	2,500	1,500
B. Coli	4:00 P. M.	12,000	50,000	0	0
Total Bacteria	12 midnight	48,000	16,000	190,000	18,000
B. Coli	12 midnight	15,000	18,000	0	0
December 7—					
Total Bacteria	8:00 A. M.	1,200,000	1,800,000	24,000	30,000
B. Coli	8:00 A. M.	45,000	30,000	0	0

PHYSICAL AND CHEMICAL RESULTS

—8-Hour Test—

	Time	Screened Sewage	Basin Effluent
Total Alkalinity	12:15 P. M.	106	193
Total Alkalinity	4:00 P. M.	103	326

—24-Hour Test—

December 6—			
Total Alkalinity	8:00 A. M.	98	380
Total Alkalinity	12:00 M.	89	276
Total Alkalinity	4:00 P. M.	88	252
Total Alkalinity	8:00 P. M.	98	282
December 7—			
Total Alkalinity	12:00 midnight	85	288
Total Alkalinity	4:00 A. M.	86	341

SCREENINGS REMOVED

—24-Hour Test—

Bar Screen ..... 117 lbs.
Plate Screen ..... 379 lbs.

RESULTS EXPRESSED IN PARTS PER MILLION

—24-Hour Test—

	Raw Sewage	Screened Sewage	Cell Effluent	Basin Effluent
Total Solids	217	248	608	640
Volatile Solids	114	140	196	94
Fixed Solids	103	108	412	546
Suspended Solids	74	69	215	26
Nitrogen as				
Organic	34.5	34.2	21.5	21.6
Free Ammonia	11.3	11.5	9.2	9.3
Nitrites	0.045	0.05	0.06	0.06
Nitrates	0.46	0.45	0.93	0.90
Oxygen Consumed	53	52	44	44

Raw sewage samples were collected from the discharge pipe of the pump after sewage had passed the bar screen. Screened sewage samples were collected after the sewage had passed the bar screen, the pump, the plate screen and the grit chamber. The samples of the cell effluent were taken from the observation flume. This sewage had passed the bar screen, the pump, the plate screen, the grit chamber and the electrolytic cell and had also received the lime treatment.

DISSOLVED OXYGEN

	Time	Temperature Degrees C	Content P. P. M.	Saturation Per cent.
Cell influent	10 A. M.	12.0	3.7	34
Cell effluent	10 A. M.	11.0	5.2	47
Cell influent	6 P. M.	12.0	6.8	63
Cell effluent	6 P. M.	11.0	7.0	63
Cell influent	2 A. M.	12.5	6.7	62
Cell effluent	2 A. M.	12.5	8.3	77

PUTRESCIBILITY

Using Methylene Blue at 20 degrees C

—8 Hour Test—

	Raw Sewage	Screened Sewage	Cell Effluent	Basin Effluent
1:45 P. M.	1 day	1½ days	4½ days	9½ days

—24 Hour Test—

Dec. 6				
9:00 A. M.	1 day	1 day	14 days	14 days
3:00 P. M.	1½ days	1½ days	14 days	14 days
11:00 P. M.	1½ days	1½ days	14 days	14 days
Dec. 7				
7:00 A. M.	1½ days	1½ days	14 days	14 days

PUTRESCIBILITY OF SLUDGE FROM RESETTLING BASINS

	100% sludge	75% sludge 25% river water	50% sludge 50% river water	25% sludge 75% river water	100% riv. water
Standard Quantity Methylene Blue Solution	3 hrs.	3 hrs.	3 hrs.	3 hrs.	14 days
3 Times Standard Quantity Methylene Blue Solution	3 days	14 days	1 day	3 days	14 days

In the above table the entries signify the period during which the samples retained a blue color excepting in cases where the entry reads 14 days, which signifies that the color was still present when the samples were thrown away at the end of the 14-day period.

It was feared the bleaching properties of the lime would have a marked effect on the methylene blue solution added to samples of sludge mixed with varying proportions of the river water. Accordingly, the standard quantity of methylene blue solution was added to one set of samples and three times this standard quantity to the check set, including the control samples. It will be noted that the samples of 100 per cent river water were stable for two weeks in both cases, but in the other samples, containing varying proportions of sludge and river water, the lime apparently had a perceptible effect upon the methylene blue. The samples containing the greater proportion of methylene blue retained the color for longer periods although the period of retention of color was not proportional to the percentage of river water, tending to throw some doubt upon the accuracy of this determination.

The appearance of the raw sewage was typical of fresh dilute sanitary sewage from an American municipality except at times when brewery wastes are present.

The effluent from the electrolytic cell had a brownish cast, contained a floculent precipitate and evidenced tendency to form a floating froth in the observation flume and inlet end of the settling basin. The floculent precipitate settled rapidly, leaving a clear greenish tinged supernatent liquid excepting

when large volumes of brewery wastes were passing through the plant when the effluent from the basin was clear amber color and contained some suspended matter.

There was no opportunity during the test to determine the feasibility of drying sludge from the settling basin upon the sand beds.

At the end of the 24-hour test the cover on the effluent end of the electrolytic cell was removed and the electrolyte drawn down a short distance below the top of the plates. After removal of the coating these plates as far as could be seen were bright and in good condition. The coating, which was removed easily by rubbing with the fingers, was found on analysis to contain 1.73 per cent. of iron.

There was no evidence during the test that under operating conditions there is a rapid deterioration of the plates to form a chemical coagulant which was purposely intended in the early processes for the electric treatment of sewage.

Life of Electrolytic Cell

The company states that the cell under test at Easton had not received any repairs during the summer and in fact the cell cover had not been removed prior to the conclusion of the 24-hour test when it was opened at request of the Department representatives in order to observe the condition of the plates.

Records of electric current consumed during the summer of 1918 (May to October, inclusive), were obtained from the monthly statements of the local electric company. It was found that the current consumed by the pump would have been sufficient for approximately 18 days' continuous operation and current recorded by the meter supplying circuits for the lime feeding and mixing devices, the solution pump, electrolytic cell and revolving paddles would have been sufficient for approximately 16 days' continuous operation. These periods are obtained by using the current consumption during the 24-hour test as a basis. The higher figure for the pump is probably due to the fact that the flow of sewage was greater on some days than during the 24-hour test while the current required for the lime feed and the cell did not vary uniformly with the flow of sewage.

The company states that the cell remained filled with sewage during periods when it was not operated.

Freedom from Nuisance

During the department's test the entire apparatus was free from objectionable odors. Inquiry was made at houses in the vicinity and it was found that the residents quite generally had no cause for complaint.

There is little reason to anticipate nuisance conditions from the screens, cell or settling basins when handling fresh sewage for there would normally be dissolved oxygen present throughout the process. Freedom from nuisance, however, cannot be predicted with any degree of certainty in a large municipal plant which must necessarily contain sludge beds or sludge presses for dewatering the sludge. In fact it is altogether probable that disposal of the sludge would at times be attended by offensive odors.

Cost of Operation

It is difficult to predict, with a satisfactory degree of accuracy, the cost of operating a large unit by comparison with data collected through operation of a single small unit. However, in the absence of complete information, reliance must be placed upon such data as are available and reasonable factors applied to meet expected conditions in the larger plant. The following figures regarding cost of operating the plant at Easton are therefore given as a rough indication of what might be expected, but apply more particularly to a plant of a similar size operating under the same conditions, namely, pumping of sewage and the addition of lime at a rate stated by the owner of the patent as being greatly in excess of that necessary to secure satisfactory results:

Without Pumpage—	
Hydrated lime—1,712 lbs. @ $6.75 per ton	$ 5.78
Water for mixing lime—20 cu. ft. @ $0.003 per cu. ft.	.06
Electric power—130.6 k.w.h. @ $0.0226	2.95
Electric lights—6¼ k.w.h. @ $0.0805	.50
Heating	1.25
Labor and superintendence	15.00
Electrode renewals—company's estimate	1.00
Maintenance and repair	1.50
Total	$28.04
Add for Pumpage—	
Electric power—88.3 k.w.h. @ $0.0226	2.00
Water—120 cu. ft. @ $0.003 per cu. ft.	.36
Total	$30.40
Equivalent cost per million gallons	$66.00

These figures are on the basis of pumping and treating 460,600 gals. excluding allowance for interest and sinking fund charges and cost of sludge pumping, treatment and disposal. The costs of hydrated lime, water and electric current are those which the department understands obtains at Easton. The figure for labor and superintendence is based upon employment of a superintendent at $1,650 a year who should be able to make necessary bacteriological and chemical tests, and who is familiar with the theory of operation of the process and upon employment of an operator on each 8-hour shift at a salary of $1,200 a year.

If we assume that the plant could be operated continuously at normal rating (1,000,000 gals. a day) the unit costs would be materially reduced and would probably be approximately as follows:

Without Pumpage—	
Hydrated lime—3,720 lbs. @ $6.75 a ton	$12.56
Water—20 cu. ft. @ $0.003 per cu. ft.	.06
Electric power—185.5 k.w.h. @ $0.0226	4.19
Electric lights—6¼ k.w.h. @ $0.0805	.50
Heating	1.25
Labor and superintendence	15.00
Electrode renewals	1.00
Maintenance and repairs	1.50
Total	$36.06
Add for Pumpage—	
Electric power—117.7 k.w.h. @ $0.0226	2.66
Water—120 cu. ft. @ $0.003	.36
Total	$39.08

These figures are exclusive of allowance for interest and sinking fund charges and cost of sludge disposal. It will be noted that the lime has been increased proportionately to the flow as this quantity was added during the test. Should it later appear that the quantity of lime can be reduced without deterioration of the effluent there would be a corresponding reduction in cost of treatment. It is probable that the cost of sludge pumping, treatment and disposal will be in the neighborhood of $7.50 a million gallons.

Conclusions

Consideration of the performance of the plant as operated by the owners and as observed by members of the Engineering Division of this department on Dec. 4 and 6, 1918, leads to the following conclusions:

1. The combined action upon the sewage of the fine screen, lime treatment and the electrolytic cell render the sewage in such a condition that after sedimentation in properly designed tanks the effluent can be discharged into a stream, affording a reasonable dilution of relatively clean water, without danger of creating nuisance. It is of course assumed that the effluent will be discharged through properly designed outlet so as to cause dispersion in the stream.

2. The fine screen, lime treatment and electrolytic cell have a destructive action on bacteria of the colon group. If, however, the use of the receiving body of water demands a high degree of bacterial removal in sewage effluents discharged therein, it would be on the side of safety to provide for disinfection of the cell effluent.

3. Assuming fresh domestic sewage, proper design, operation and maintenance of the various devices the treatment of sewage by the above described processes should be free from objectionable odors, with the possible exception of the removal and disposal of the screenings and the sludge from the final settling basins.

4. Similar screenings are being successfully disposed of elsewhere by incineration or burial and the sludge from the final settling basins should be susceptible of dewatering by presses such as are used in sewage treatment works, including the lime precipitation method.

5. The process should be extended by installation of some adequate method for treatment of sludge removed from the settling basins, as discharge of this sludge with the cell effluent is not permissible.

6. The cost of installation of a sewage treatment works including the above processes should not be excessive but the cost of operation would appear to be higher than for other methods of sewage treatment in general use to produce an equal quality of effluent.

Each proposed installation should be examined by comparison with other methods of sewage treatment to determine if savings in installation cost would be sufficient to counter-balance the increased maintenance and operation charges.

If it should be determined that the proportion of lime could be materially reduced without deterioration in the quality of effluent, there would be a proportionate reduction in operating costs.

7. To permit continuous operation of a works including these processes, electrolytic cells and other equipment must be in duplicate. It is undoubtedly necessary to replace plates in the electrolytic cell from time to time and accordingly a type of cell should be adopted which admits of such renewals in place and at a minimum cost for labor.

8. The short time observations of the combination of fine screening, lime treatment, electrolytic cells and final settlement appear to justify an extended test by this department should the opportunity be offered. Such test should include study of results secured with lime additions reduced to the proportion the owner of the patent claims as the actual needs of the process and should also include study of various methods of treatment and disposal of the sludge from the settling basins.

Special Features of the Gallery Water Collecting System of the Des Moines Water Co., Des Moines, Ia.

By A. F. Luce, C. E., Engineer and Superintendent, Des Moines Water Co., Des Moines, Iowa

The Des Moines Water Company is one of the pioneers, if not the first, thoroughly to develop its water supply by means of infiltration galleries. A number of cities have water supplies developed from the underlying sand and gravel strata by means of wells, but few, if any, have adopted the method used here.

In order to understand thoroughly the practical application of this method it will be necessary first to fix clearly in mind the fundamental features of the water bearing area before undertaking to follow through the various stages of its development.

Source of Supply

The water is obtained primarily from the Raccoon River. This stream lies in a southwesterly direction from Des Moines and discharges into the Des Moines river in the heart of the city. It has a drainage area of 3,677 square miles above the city and a minimum flow of sufficient quantity to more than meet the needs of the city for many years to come.

Geological Conditions

The most interesting feature of the river from a water supply standpoint is the geology of its valley in the vicinity of Des Moines. Here we find a broad valley nearly 100 ft. deep and a mile wide, which has been eroded in the clay, shale and rock of the natural topography and extending for many miles upstream with relatively steep sides terminating in rolling plains above. It is evident that this valley was eroded by a preglacial stream which eventually cut its way to a hard bottom and later covered this bottom with clean sand and fine gravel brought down from the glaciers and then, at a still later period, covered this gravel bed with from 5 to 10 ft. of alluvium. As might be expected, this stratum of sand and gravel terminates at the foothills on either side, but extends upstream for many miles. Borings have shown this to be true and many made by the water company affirm the fact that it is from 10 to 30 ft. in thickness, very clean and uniform in size. An analysis of the borings show no marked difference in the character of the material although in some places the sand predominates and in others the gravel. There is, however, little difference in the water-carrying capacity, the average effective size being about 0.42 millimeters with a coefficient of uniformity of 4.00.

Raw Water of Good Quality

Owing to the fact that the surface of the valley lies below the level of the flood plane of the river it is sparsely settled both within the city and for a long distance above it. Thus we find extending right into the city a large sand and gravel filled basin sealed off from practically all outside contamination by the topography and the natural clay soil, through which meanders a river of ample size to furnish the water requirements for many years to come. During the greater portion of the year this river is low in turbidity, but is subject to floods that periodically scour the silt deposits from its bed.

Early Infiltration Tanks

It was concluded early in the development of the water company that the sand of the river would act as a good filtering agent and there was accordingly constructed in 1871 a steel tank 12 ft. in diameter and 14 ft. high with perforated sides and closed top. This tank was sunk in the gravel on the south bank of the river until its top was 10 ft. below low water and it was surrounded with coarse gravel. It has been estimated that this tank furnished water at the rate of 1.5 million gallons per day for short periods. A direct river inlet was later connected for emergency use.

In 1876 two more tanks were installed on the north bank of the river. Those were very much similar to the original, being 12 ft. in diameter and 12 ft. high with perforated sides and open bottom, but having tops constructed of 12x12 in. timbers.

The Present Collecting System

The first unit of the present collecting system was built in 1882. This was the suction well located in the station yard and approximately 800 ft. from the river. It consists of a brick lined well 50 ft. in diameter and 35 ft. deep with walls 19 ins. thick, resting on an iron shoe. The well is roofed over below the ground and contains the suctions of the pumping engines. The top of the well is about 15 ft. above the normal river level. Upon completion the well was capable of delivering 500,000 gallons per day. With this well and the three boxes a supply of from 2 to 3 million gallons per day was obtained, although the draft upon the boxes was beginning to draw sand into the pumps and give more or less trouble.

No. 1 Gallery

In 1884 work was started on the first gallery. This gallery is known as the No. 1 Gallery, and extends from the suction well south under the tracks of the Rock Island railroad a distance of 260 ft., thence in a westerly direction along the railroad, between it and the river for a distance of 817 ft., terminating at a point 150 ft. from the river bank. It is 4 ft. high by 5 ft. wide, and surrounded with 1 in. screened stone. The bottom is open and the sides and top are made of 3x6 in. white elm timbers, laid with ⅜ in. spaces between. The gallery was built in open cut, the ditch varying from 17 ft. to 27 ft. in depth. It was completed in 1886.

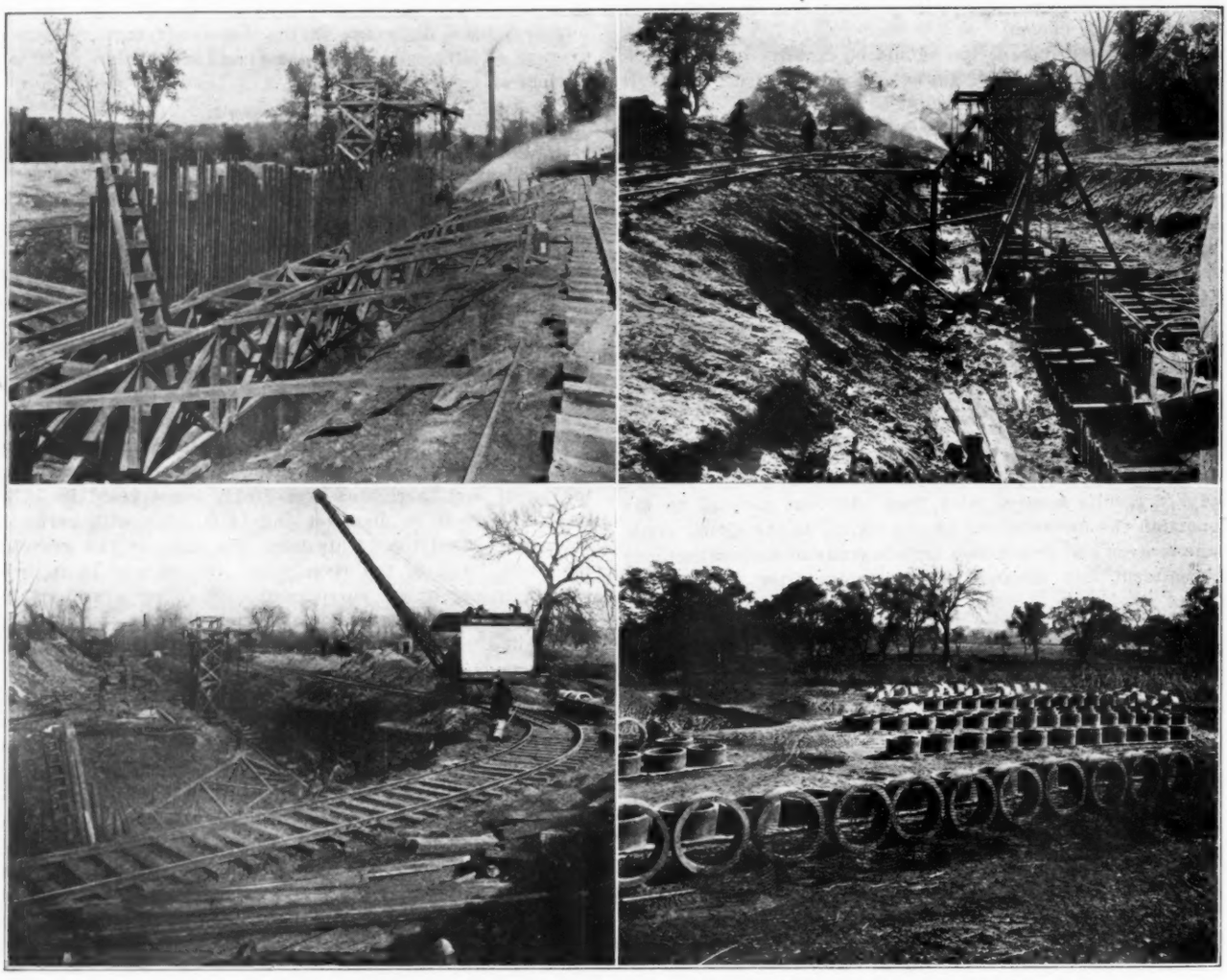
The old iron tanks were abandoned in 1885, and the water drawn entirely from the No. 1 Gallery and the Suction Well. Thus we find that 34 years ago the entire water supply was developed by infiltration at a considerable distance from the river.

No. 2 Gallery

Owing to the steady growth of the city and the increasing demand for water, the No. 2 or River Gallery and river well were built in 1887. The well was located in the station yard and is 20 ft. in diameter by 30 ft. deep, built with 20 in. brick walls, resting on a wooden shoe. It is roofed over with brick arches supported by I-beams. In order to prevent wash from the gallery one-half of the bottom is floored with a baffle in the center. This gallery is 1,594 ft. in length, and lies along the foot of the bluff on the north side of the railroad, terminating in an emergency inlet to the river. Like the No. 1 Gallery, it is constructed of white elm timbers in open cut, varying in depth from 16 ft. to 30 ft. It is smaller, however, in size, being only 4 ft. wide by 4 ft. 2 ins. high, with open bottom and tightly sheeted sides and top made of 4x6 in., white elm timbers set on a bed of screened broken limestone. At the time of completion of this gallery, there was ample infiltration to supply the domestic and fire demand of the city without recourse to the emergency river intake, the average daily consumption being about 2,000,000 gals.

No. 3 Gallery

It was not necessary to augment this supply by additional galleries until 1894, when the consumption had increased to an average of nearly 3,000,000 gals. per day. During this year the No. 3 Gallery was constructed. This gallery is an extension of the No. 1 Gallery beginning at the end of the old gallery and extending across the river and upstream parallel to it for a total distance of 1,250 ft. It is 3 ft. 8 ins. high, by 5 ft. wide and was built with sides of 4x6 in. timbers in which ¼ in. spaces were left between timbers. The top was made solid, 8 ins. in thickness, and, like the other two galleries, the bottom was left open. Screened gravel was placed on the sides and bottom of the gallery. For 150 ft. under the river the gallery is protected by a 4 in. concrete slab. A low brush and rock fill dam was thrown across the river below the galleries in the fall of this year, which increased the head on the galleries about 2 ft.



VIEWS ON THE CONSTRUCTION OF A WATER INFILTRATION GALLERY AT DES MOINES, IOWA.
Top Row: Using Steam Hammer to Drive Solid Steel Sheeting. Bottom Row: Locomotive Cranes Employed on the Excavation-Reinforced Concrete Rings Laid on Timber Cradle and Surrounded by Crushed Sewer Tile Form the Conduit.

Five 8-in. drive wells were constructed about 800 ft. from the gallery in 1899. These wells were about 20 ft. in depth, extending nearly to the clay subsoil and were equipped with 8-ft. strainers. Pumping was done by means of an electric driven pump, which discharged into the end of the No. 3 Gallery through a 16-in. C. I. pipe line. In 1900 it was decided that the operation of this equipment was detrimental to the flow in the galleries and the wells were accordingly abandoned.

No. 4 Gallery

It was not until 1904 that additional galleries were built. The No. 4 Gallery was started in 1902, but floods and high water delayed the actual construction for 2 years. This gal-

lery forms the first link in the present main gallery line and was built of similar construction to Gallery No. 3, although it is 4 ins. higher, being 4 ft. by 5 ft. in section. It was built in open cut at a depth varying from 10 to 30 ft. and extends from a point on the north bank of the river 600 ft. from the suction well across the stream for a total distance of 1,000 ft. The end of the gallery is connected to the suction well by means of a 36-in. C. I. siphon. A 20-in. cross connection was built between galleries No. 3 and 4, in order to equalize their flow. It is of interest to note that this gallery extended at right angle to the river and at its upper end is 400 ft. from the nearest bank.

During times of low water it became necessary to irrigate and rake the sand bars along the river adjacent to the galleries in order to increase the yield. This procedure was expensive and more or less unsatisfactory, and it was decided to extend the gallery system still further. After a careful investigation of the ground water contours and a further study of the water bearing strata it was determined that over two-thirds of the water collected by the galleries came from the river and that the rate of this infiltration approximated 220,000 gals. per acre of river bed per day. It was accordingly concluded that extensions made parallel to the river would develop the greatest delivery.

Gallery No. 5

Work was started on the No. 5 Gallery in 1908. This gallery extends in a southwesterly direction from the end of Gallery No. 4, a distance of 3,325 ft., and consists of a series of concrete rings 4 ft. in diameter, laid on a timber cradle surrounded by 6 ins. of crushed sewer tile. Each ring is 2 ft. long and 4½ ins. thick, made of reinforced concrete, and has small lugs cast on one end ¼ in. high, which serve as spacers between the adjacent rings. The excavation ranged from 20 to 27 ft. in depth and due to the intensely water-bearing character of the material solid sheeting had to be adopted. Three pumping plants were used during the work as it was necessary to handle water at rates varying from 4 to 12 million gals. per day. Manholes were built at points where the direction of the gallery changed. This gallery is divided into two sections connected by 36 ft. of 36 in. cast iron pipe and a gate valve. Cast iron pipe and valves were also placed at the beginning and end of the gallery. All three valves are located in valve chambers made of brick with concrete bottoms. The work on this section of gallery was completed in 1910.

Emergency Filter

In order to dispense with the irrigation and raking of the sand bars during periods of low water, an Emergency Filter was built simultaneously with the construction of the No. 5 Gallery. This filter consists of an earthen reservoir immediately above the gallery, divided into two sections by a street crossing. The filters are 30 ft. wide at the bottom, with side slopes 1:1 and a total length of 850 ft., and are connected by a 24-in. vitrified tile. Water was originally admitted to them by gravity from the river through a 20-in. cast iron pipe. The bottom is at elevation 100 and the tops of the banks are at elevation 120. Without the Emergency Filter this gallery produced about 2,000,000 gals. per day and it was thought that there would be no further extensions needed for some time as the average daily consumption of the city was about 5,250,000 gals. per day. The demand for water, however, became greater than was anticipated as the consumption increased over 50 per cent. between 1907 and 1913, at which time it became apparent that the galleries would have to be again extended and accordingly work was started on No. 6 Gallery in the fall of 1914.

Gallery No. 6

The No. 6 Gallery begins at the end of Gallery No. 5 and parallels the river for a distance of 3,500 ft. It is identical in construction with the latter gallery and is likewise divided into two sections by a short stretch of 36 in. cast iron pipe and a valve. The excavation ranged from 18 to 20 ft. in depth, and was done by two locomotive cranes, operating on standard-gauge track on either side of the excavation. Steel sheet piling was used for lining the trenches, and was driven by steam hammers supported by the cranes. Water was pumped from the ditch at rates varying from 2 to 8 million gallons per day. This gallery was completed and put into operation early in 1917, and completes the extensions up to the present time.

Low Lift Pumping

Owing to the lowering of the river level about 2 ft., by sand dredging operations and the inadvisability of raising the brush and rock fill dam previously mentioned to a sufficient height to overcome this loss in head, it became necessary in 1916 to install a motor driven low lift centrifugal pump of 5 M. G. D. capacity, to furnish water to the Emergency Filters during periods of drouth. This plant was replaced the first of this year by a permanent low lift pumping station, located at the extreme end of No. 6 Gallery. The station contains 2 motor-driven centrifugal pumps each of 5 M. G. D. capacity, which take their water from the river and discharge it into a series of ditches and pools extending along the land side of the gallery as far as the Emergency Filters. It has been demonstrated that this method of irrigation furnishes water of equal quality to that filtered from the river and that it filters at the rate of about 1 M. G. D. per acre flooded. At present only one pump is operated, and then during low water stages of the river although the average daily consumption has grown to over 8 M. G. D., and a maximum rate of 17 M. G. D. was reached last August for a short time.

In the normal operation of the galleries the pumping engines at the pumping station lower the water level of the suction well by their demand and this unstable condition of the ground water level thus created causes a draft on the gallery conduits which in turn is replenished by infiltration from the adjacent water-bearing area. The ground water then flows from either side towards the gallery; the greatest amount, however, coming from the river side. During periods of high pumpage the ground water level immediately adjacent to the river has been drawn down to a foot below the level of the water in the river. This heavy draft does not increase the yield from the river as much as might be expected, as it is limited by the permeability of the bed of the stream.

Efficiency of Natural Filter

In conclusion, it is of interest to note the bacterial results of the operation of this natural filter plant. A chemist and two assistants are regularly employed to observe the character and quality of the water, making daily analyses of water from the river, suction well, and tap. During last year the average daily bacterial count of the river, with samples incubated at 20 degrees centigrade was 19,047 per cubic centimeter, while that of the suction well, as filtered through the sands, was 1,061, showing a reduction of 94.5 per cent. The water is further treated with chlorine gas applied by an automatically operated machine which reduced the average daily count for last year to 47.5, or a total reduction of 97.5 per cent. It might be added that this average count at the tap is about double the normal actual count per day, the increase being due to a few high counts caused by abnormal fluctuations in the river.

Acknowledgment

The foregoing is a paper presented by Mr. Luce at the recent annual meeting of the Iowa Section of the American Water Works Association.

How to Provide a County with Good Roads

The improvement of county roads has become so urgently necessary to the proper development of the resources of the

county, says the Highway Industries Association, that it is necessary for the county authorities and citizens to devise ways and means of bringing about such a development.

In undertaking this improvement, a number of important features have to be taken into consideration and given careful study. The entire road mileage of the county must be ascertained; the number of miles of roads that it will be advisable to improve; the character of the traffic, that passes over each road; an estimate of future traffic; the ability of the county to raise sufficient funds to improve the mileage selected; and the methods by which this money can be raised.

A close study should be made of the present taxable basis, and the financial obligations of the county, the tax rate, and the amount it would increase the tax rate to build the roads by a direct tax or by bonds. The financial ability of the county having been ascertained, the approximate amount of money the county can raise by bonds or otherwise determined, and the roads classified, a system can be laid out in keeping with the amount of money to be expended with adequate provisions for maintenance.

It is most important that a close study be made of the existing roads, a system laid out, and the cost of improving such a system determined. In estimating the cost, provision should be made for future maintenance so that the burden placed on the county would not be such as to raise the annual tax above that prescribed by law or become burdensome to the taxpayer. Bonds should be of the serial variety, life not exceeding 25 years, preferably 20 years, and bearing a rate of interest that will make them attractive to investors.

The roads selected should be so co-ordinated as to form a complete system, connecting up the most important points and railroad stations in the county. If the county has no county engineer, the services of an experienced road engineer should be secured to lay out the system, and make an estimate of its cost of construction, and maintenance.

The system of roads having been selected and laid out, cost of construction ascertained, and the financial ability of the county being found capable of constructing such a system, it will then be necessary to plan a campaign of information and education, so that when the issue is put before the voters it will be clearly understood, and the great benefit to be derived may be fully known to every voter.

The best way to bring this about, is to form A Good Roads Organization such as a County Good Roads Association; elect a chairman, a vice-chairman, for each district of the county, and a secretary. Under a vice-chairman each district should form a committee, bringing together as many people as possible who will work for the passage of the bond issue or special law by calling the attention of the members of the legislature, and all the people to the great need for improved roads and the benefit that will be derived therefrom. The committee should extend their activities to such community in the district by holding meetings and sending out literature, setting forth clearly the object of the campaign and what it hopes to accomplish.

Movement to Construct National System of Trunk Line Highways Gains Momentum

The movement to construct a national system of trunk line highways intersecting each state, the cost of construction and maintenance to be borne by the Federal Government, is gaining throughout the country, according to reports coming into the Federal Highway Council.

Many letters are coming in from practically all sections endorsing the movement and calling for explicit information as to the main points in the national highway measure, now pending in the Senate. It is expected to come up for further consideration at an early day.

The national highway bill, introduced by Senator Townsend, chairman of the Senate committee on postoffices and post roads, is an entirely new piece of legislation. Its object is to build in each state, trunk line highways to the extent of not less than 2 per cent., nor more than 5 per cent. of the total mileage of the state, and to join them with the main trunk lines of other states, thus creating a national system connecting the entire country.

The decided trend in public opinion in favor of Federal construction of a national highway system is due, according to those having the measure in charge, to the fact that such mileage as each state will receive will put the state that much nearer to a complete and well connected state system, at the same time insuring logical connections with adjoining states. It is admitted that such connections are necessary to a properly co-ordinated system and that such co-ordination is logically a federal function.

The net result to each state, it now begins to appear, will be a strengthening of forces behind road development. The states on the one hand are to be aided by relieving them permanently of the construction and maintenance of the heaviest traveled interstate routes, thus permitting the concentration of state effort on routes having their terminal points within the state. In other words, more effective co-operation of federal and state power is to be gained by each having its specific work laid out, one applying its efforts to national connections and the other to the development of local or intra-state roads and their proper connections.

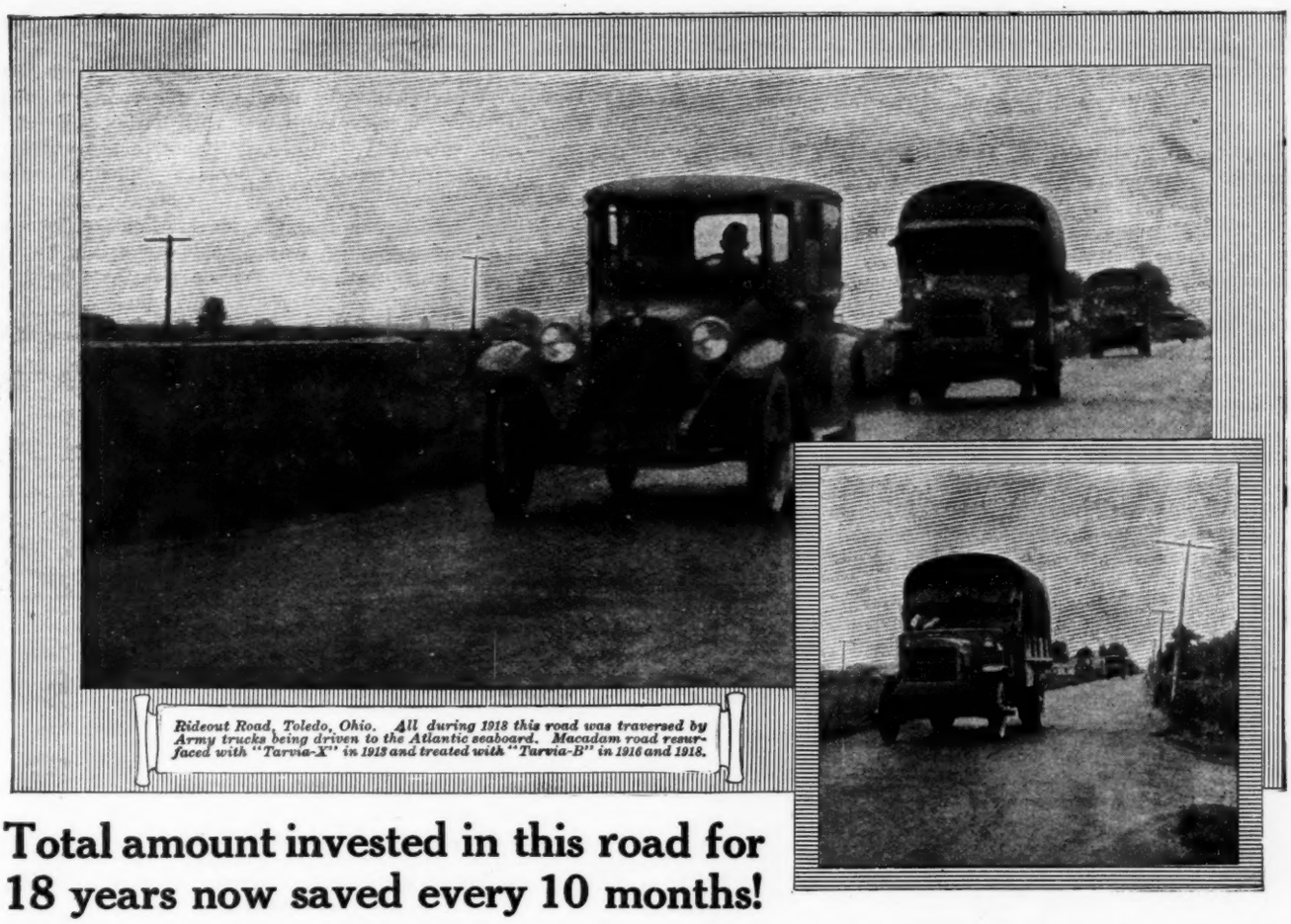
Supporters of the national highway movement are increasing their activities in the expressed belief that in the pending measure they are working for a plan whereby a comprehensive system of national highways may be constructed and put into permanent operation within the next few years, and at less cost to the public than under any other plan.

Analysis of Statically Indeterminate Structures by the Slope Deflection Method

In recent years rectangular steel frames with riveted joints have been used, and many types of monolithic reinforced concrete frames have been developed. The use of statically indeterminate stresses cannot, accordingly, always be avoided. Structures are frequently made of an indeterminate type to secure economy of material. It is felt that analyses of statically indeterminate structures are desirable since such information will do much to inspire confidence in the reliability and in the economy of such structures.

An investigation of statically indeterminate structures has been conducted by the Engineering Experiment Station of the University of Illinois to obtain a convenient method of analyzing the moments, stresses and deflections for a number of typical structures. The analyses were based upon the assumptions that the connections are perfectly rigid, that the length of a member of a rectangular frame is not changed by axial stress and that the shearing deformation is zero. The method used in the analyses and the equations derived are published in Bulletin 108, entitled, "Analysis of Statically Indeterminate Structures by the Slope Deflection Method," by W. M. Wilson, F. E. Richart and Camillo Weiss. The method has been explained in sufficient detail to enable the designing engineer to use it in the solution of his problems. It is believed that the fundamental principles presented may be readily co-ordinated with the ordinary principles of mechanics so that the more complex and even the simpler problems may be studied from a new viewpoint.

Copies of Bulletin 108 may be had without charge by addressing the Engineering Experiment Station, Urbana, Illinois.



Rideout Road, Toledo, Ohio. All during 1918 this road was traversed by Army trucks being driven to the Atlantic seaboard. Macadam road resurfaced with "Tarvia-X" in 1918 and treated with "Tarvia-B" in 1916 and 1918.

Total amount invested in this road for 18 years now saved every 10 months!

THIS is Wood County's heaviest travelled road. All automobiles and motor trucks in transit overland around the western end of Lake Erie from Detroit and Toledo to the East must drive over this highway. In fact, most of the overland motor traffic to the South also takes this route.

Mr. John F. Gallier, County Surveyor of Wood County, recently figured that this highway carries 2,000 tons per day for its entire length of 7.36 miles, or more than 5,330,000 ton-miles per year!

This road is a Tarviated highway, and in a very interesting article Mr. Gallier develops the fact that *every ten months* the saving in the cost of operating motor traffic over this highway, as compared with that on a well-drained clay road, *equals the total investment in the road for the past eighteen years.*

Space is too limited to give Mr. Gallier's figures in detail, but a copy of the article, which gives the history and maintenance figures of the road since 1900, will be sent to any interested road engineer or taxpayer upon request.

Briefly, the total investment in the road for 18 years, including three Tarvia treatments, is $99,367.63, or a trifle more than $13,500 per mile.

Figuring carefully and conservatively, Mr. Gallier has worked out the difference in cost of gasoline, tires and oil alone (not taking into account the saving in wear and tear on automobiles and trucks), for traffic over the Tarvia road as compared with the same traffic over a well-drained clay road. Reduced to totals, the figures are:

Total average daily cost of gasoline, tires and oil for motor traffic on clay road . . .	$714.62
Total average daily cost of gasoline, tires and oil for motor traffic on Tarvia road . .	381.73
Daily difference in favor of Tarvia road . .	$332.89
Difference for 365 days	$121,475.85

This means a saving of $10,122.98 per month, or $101,229.80 every 10 months, which is more than the improved road cost to build and maintain for 18 years, including interest, engineering and drainage costs!

Tarvia is ready to serve other communities as it is serving this one, helping them to build and maintain mudless, dustless, automobile-proof roads at low cost—*roads that pay for themselves—roads that are an asset instead of a liability.*

Interesting descriptive booklet telling all about this interesting proposition free on request.

Tarvia

Preserves Roads~Prevents Dust

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

New York, Cleveland, Birmingham, Seattle, Youngstown, Chicago, Cincinnati, Kansas City, Peoria, Toledo, Philadelphia, Pittsburgh, Minneapolis, Atlanta, Columbus, Duluth, Richmond, Winnipeg, Milwaukee, Latrobe, Vancouver, Dallas, Bangor, Bethlehem, Boston, Detroit, Nashville, Washington, Elizabeth, St. Louis, New Orleans, Salt Lake City, Johnstown, Buffalo, Baltimore, Lebanon

THE BARRETT COMPANY, Limited: Montreal, Toronto, St. John, N.B., Halifax, N.S., Sydney, N.S.

Much Interest in International Municipal Exposition

Since the recent announcement of the International Exposition of Municipal Equipment to be held as a permanent institution in Grand Central Palace, New York, considerable comment has been made in various interested circles throughout the country. Miss Jeanne Carpenter, who is to be the exposition director, has received many letters from manufacturers of municipal equipment, city officials, chambers of commerce, etc., praising the idea and speaking sanguinely for the success of the enterprise. Miss Carpenter is the author of the book, "Municipal Housecleaning." She has had years of experience in this field in various parts of the country and abroad. Her ideas for the exposition are decidedly practical and with the backing that the exposition enjoys, it is an assured success.

The International Exposition of Municipal Equipment is to be one of the eight or nine expositions which will make up the great industrial trade mart of the Merchants and Manufacturers Exchange, occupying the entire Grand Central Palace. The Municipal exposition will be staged on the whole floor with 50,000 sq. ft. floor space. The Merchants and Manufacturers Exchange of New York, which operates Grand Central Palace, is owned and controlled by the Nemours Trading Corporation, of which Alfred I. Du Pont is president. This corporation has representatives in all leading cities throughout the world, consisting of 19 branch offices and 3,000 foreign selling agencies.

The exposition is to include all that pertains to the construction and proper management of municipalities—for water, heat, light, power, fire protection, health, education, policing, amusement, and other departments. City officials, municipal engineers, members of Chamber of Commerce from many cities throughout the world will visit Grand Central Palace and the permanent Municipal Exposition will afford a most convenient means of putting the manufacturer of equipment in direct touch with the interested buyer.

A number of letters received by Miss Carpenter state that there has been an urgent need for just such an exposition as this. Detailed information can be obtained by writing or calling at Suite 421, 405 Lexington Avenue, New York City.

Removing a Concrete Engine Bed by Blasting

In removing an old engine bed or foundation, holes should be drilled vertically to a depth at least three-quarters the thickness of the piece. If there is machinery nearby or other property likely to be damaged, it is best to fire only one hole at a time. It is difficult to say definitely just how to space the holes, because the shape and dimension of the bed may be very irregular, but it can be taken as a safe rule to use about one-third of a 1¼ x 8 in. cartridge of ammonia 40 per cent. dynamite per cubic yard of material to be broken.

More can sometimes be used with safety, but as a general rule, if the charge is thus proportioned, no material will fly and yet it will be crumbled and cracked up so that it can be readily removed by hand labor.

An engine foundation 12 ft. long, 4 ft. deep, about 3½ ft. wide, was successfully broken by drilling three vertical holes, each 3 ft. deep, along the center line, using one-third cartridge of 40 per cent. ammonia dynamite 1¼ x 8 in. per hole. One hole was shot at a time.

Dynamite was successfully employed in breaking up a brick and cement foundation for heavy machinery. The base was a solid mass, 8 to 10 ft. deep. The method used was as follows: Eight holes, 5 ft. deep, were drilled vertically into the block. Small charges of dynamite were loaded in the holes and well tamped in. Electric blasting caps were inserted, in all eight charges, and by means of the wires connected up in series on the surface so as to get the cumulative effect of a combination shot.

As there was a large skylight less than 30 ft. from the base, besides other machinery nearby in the room, it was necessary to cover the bore holes first with burlap bags and afterwards with some heavy pieces of timber to prevent flying pieces of masonry from causing damage. When all was ready the charges were connected up to a blasting machine and fired. The result was that the block of masonry was shattered so that the various pieces could be handled and carried away by laborers. The entire job was done in two hours.

Pave Now!

"Next year we will win," was the Allied boast,
While it sparred and felt out the Teuton host.
And press and rostrum proclaimed the day
Of Victory—always a year away.

But Foch was a man of different mind,
Chafing at schedules a year behind;
He forced the arrogant foeman to bow,
By betting divisions on each golden NOW.

"Next year we will pave," is the laggard's plan,
Shirking decision as long as he can;
While capital stagnates and idle men reek
Of the fatuous cult of the Bolshevik!

Oh, vainest illusion to "pave next year"—
That mythical season that never gets here!
One season—one moment, does fortune allow
For the use of mankind, and that moment is NOW.

Present Status of State and Federal Aid Road Work in Alabama

The following is status of State and Federal Aid work at present time in Alabama:

50% of cost and estimates is paid by the Government

Completed, cost	78.78 miles,	$299,268.99
Under Construction, cost.....	97.73 miles,	532,089.76
Approved—work pend., cost..	111.45 miles,	599,130.91

From the above it will be seen that there is under way and pending 209.18 miles of road work to cost $1,131,220.67.

The State Highway Department has no authority over County work and has no way of knowing with any degree of accuracy how much work is contemplated by counties. No counties are issuing bonds.

Added Life for Galvanized Iron

Many firms and individuals who use galvanized iron seem to believe that since it is galvanized, it is automatically proof against all forms of deterioration, due to exposure to the elements. It is quite true that galvanized iron is one of the most durable materials of its weight and will stand quite a large amount of exposure before beginning to rust. However, continuous exposure to moisture will start the molecules of iron to rusting and when once through the outer galvanized coat, the damage is done.

This could be avoided by the use of a galvanized iron primer. After a primer has been applied, a good rust inhibitive paint should be used. This gives life to the galvanized iron and also prevents the formation of rust which would occur if the iron were not painted.

Many large users of galvanized iron about their factories are beginning to realize that in order to secure the best results from a standpoint of economy and service, it is necessary to paint the iron at intervals of two or three years. This policy adds many years of life to their sheds and buildings on which the galvanized iron is used.

WATER WORKS SECTION

How the Water Supply for 6,000,000 People Is Made Safe

By Wm. W. Brush, Deputy Chief Engineer, Bureau of Water Supply, Gas and Electricity, Municipal Building, City of New York

Imagine if you can six millions of people, or three times the number of soldiers we had in France, living in an area that is 32 miles in length by 15 miles in width, occupying some 360,000 buildings, each one daily requiring 35 kitchen-size pailsful of water, or enough pailsful each day to extend one and two-thirds times around the earth if placed in line, and you then have some idea of the magnitude of the task of supplying New York City with its water supply.

Under the law the duty of seeing to it that an ample supply is at all times available is placed on the Department of Water Supply, Gas and Electricity, to which is also given the responsibility of maintaining pure and wholesome the water so furnished. This is no small undertaking, and can only be successfully executed by constant effort of a small army of men, some of whom must be on duty at all times of the day and night, and for every day in the year. The detailed story of how sufficient water is gathered, stored, and then delivered through great aqueducts of a total length of several hundred miles, is a most interesting one, but we are not now to set this forth, but to tell how this vast quantity of water is guarded and made safe for all to drink freely of it, whether one lives in the most crowded tenement or dwells in a palace on Fifth Avenue.

Jurisdiction of the Commissioner of Water Supply, Gas and Electricity

The charter places on the Commissioner of Water Supply, Gas and Electricity the responsibility for "the preservation of all lakes and all waters from which a supply is drawn by the city * * * from injury or nuisance, and for the execution of such measures as may be necessary to * * * preserve and increase the quantity of water and keep it pure and wholesome and free from contamination and pollution." The health law of the state has granted to the commissioner the power to make such rules and regulations as may be necessary for the protection of the water supply, subject to the approval of the State Board of Health, said state board fixing the penalties that are to be imposed for violation of such rules and regulations.

The commissioner is also given the right summarily to abate any nuisance by seizing of property, but the city is made liable to the property owner for such action on the part of the commissioner. The law is interpreted that property owners are required to abate at their own expense nuisances where such nuisances can be abated within the limits of their own property, and the city must bear the expense of furnishing the means of abating nuisances where the property owner cannot abate the nuisances within the limits of his property. The law requires the issuing of permits for fishing, boating, and cutting of ice, to those who desire such permits, but these permits are to be issued under such rules and regulations as the commissioner may impose. There is apparently ample authority legally given to the commissioner to handle the pollution problems which may arise, but the extent to which the city is to meet the expenses requires legal determination, and in some cases, court action. So far very few cases have been brought to the courts, as settlements have been made without recourse to such tribunal.

Water Supply System

A brief summary of the water supply system of the city is a necessary preliminary to the discussion of its sanitation. New York now consumes and wastes daily about 650,000,000 gals., of which the municipal system furnishes some 610,000,000 gals., while seven private companies serve about 40,000,000 gals., to nearly one-half million people in various wards in Brooklyn and Queens. The department has supervisory jurisdiction over the private water companies as well as operating and maintaining the municipal system. Since the Catskill supply was generally introduced some two years ago it, together with the small Bronx and Byram supply, merged with it, has furnished two-thirds of the supply, the remaining third being drawn from the Croton system, leaving the former Brooklyn, Queens and Richmond supplies in reserve. We will, therefore, limit our story to the Catskill and Croton waters and to the private water companies.

BIRDSEYE VIEW OF THE WATER SUPPLY OF NEW YORK CITY.

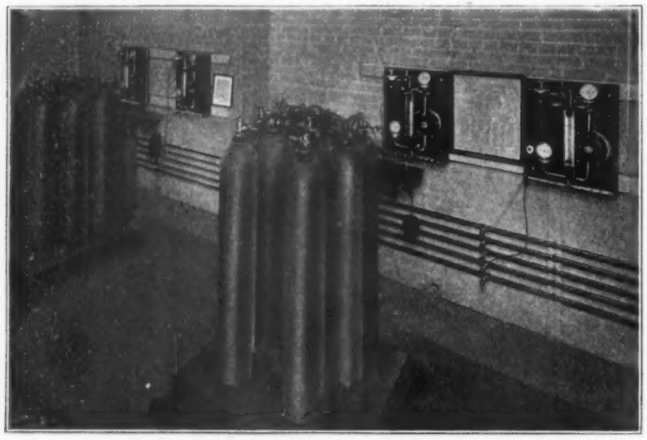
The Catskill supply is from Esopus creek, which has been damned at a point about 10 miles back from Kingston, where the Ashokan reservoir is formed, holding 130,400,000,000 gals., and forming a lake with a short line of 40 miles. About this dam there are 257 sq. miles of hills and valley, of which some two-thirds is woodland, with a resident population of 5,000 and 7,000 additional in the summer time. In the Croton

water-shed there is an area of 375 sq. miles with 16 reservoirs and ponds holding 104,400,000,000 gals., and a population of 25,000, which does not vary greatly from winter to summer. The main reservoir, and from which the supply is directly drawn into the aqueduct, is Croton Lake, where over 30,000,000,000 gals. are normally stored.

The private companies all draw their supplies from the saturated sands and gravels which underlie Long Island and the waters in which come from the rainfall, percolating slowly through the soil on its way to the bay, sound, or ocean. Small stations, each usually furnishing less than 5,000,000 gals., daily, collect this water and deliver it into the distribution mains.

What Makes Water Unsafe or Objectionable for Human Consumption

In safeguarding a water supply, consideration must be given mainly to what may cause (a) disease, (b) tastes or odors, (c) discoloration or turbidity. The disease germs, which are well recognized to be water bourne, are typhoid, cholera, and anthrax, the latter being an animal disease which rarely occurs in human beings. The typhoid and cholera bacteria can only originate in the waste discharges of human beings. It is believed that intestinal disorders are caused by



THE KENSICO CHLORINATION PLANT OF THE NEW YORK CITY WATER WORKS.

Each cylinder holds about 100 lbs. of liquid chlorine at a pressure of 125 lbs. per sq. in. The flow of this chlorine is controlled by the Wallace & Tiernan machine attached to the wall panel. This machine uniformly delivers the desired quantity of chlorine with which to treat the water.

polluted waters which do not carry any of the disease bacteria noted above, but this has not been clearly proven. Typhoid bacteria will live in what is otherwise a reasonably pure water for from several days up to about three weeks, and the resultant long period of storage required to make safe a water so polluted is evident.

Tastes and odors are popularly considered to develop from organic matter, such as leaves and grass decaying in the water. It is seldom that such is the cause, as the true cause is shown by the microscope to be minute plant or animal growths, which may multiply to many thousand units per cubic centimer (equivalent to about seven drops of water) and the majority varieties of which give characteristic tastes or odors. The organisms most common in the New York City supply, with their characteristic odors, are as follows:

Diatoms—Asterionella Tabellaria—produce geranium to gassy and fishy odor.

Cyanophyceae — Anabaena Aphanizomenon — produce grassy to pig-pen odor.

Protozoa—Uroglena—produces oily and fishy taste; Synura—produces cucumber and bitter taste; Dinobryon—produces fishy odor.

Schizomycetes (Crenothrix)—clogs well systems.

There is no harmful effect from these growths, other than rendering the supply unpleasant, and one's health will not suffer from using water in which these organisms are abundant. They may persist in a water for several months or may spring up and die out in a few days. During the past winter and spring the Kensico reservoir was shut out of direct service, due to Tabellaria being present in large numbers, and only recently has this reservoir been again regularly used.

Discoloration or turbidity of a supply is generally due either to color from a swamp area or to finely divided clay or silt, which is carried in suspension, due to heavy storms, or may come from clay springs where highly turbid water carrying a large percentage of clay is being constantly discharged. It is interesting to watch the clearly defined line between the turbid water and clear water in the Ashokan reservoir, when heavy stream flows are washing clay and silt into the head waters of the reservoirs, but usually this material is held in this portion of the reservoir and settles, without reducing noticeably the clearness of the water in the body of the reservoir.

Iron is a most frequent cause of complaint of so-called "dirty water." If present to a larger degree than one-half of a part per million by weight, it is likely to cause a yellowish red color, with a noticeable turbidity. Both the Croton and Catskill waters have a low iron content, and if iron is seen in the water as drawn it comes from corrosion of the pipes in the building, or possibly, but not likely, from the sediment in the cast iron street mains, having been stirred up by unusually heavy flow through them, such as is caused by a large fire.

Minor pollution is caused by sea gulls that in fall and winter persist in landing in large numbers in the distribution reservoirs, and which cannot be shot under the law. Dead fish, leaves and other organic matter are present to a varying amount, but do not ordinarily give trouble to the consumer.

How Polluting Substances and Objectionable Growths Are Excluded or Destroyed

In every water supply which is derived from surface waters there is always the possibility that pollution may occur at any time, and in most of such supplies it is a certainty that pollution is present at all times. This is true of the New York City supply, and the problem is how great an expense is warranted in excluding polluting matter when it is known that the supply cannot be kept free from contamination. Up to about 15 years ago it had been the city policy to purchase lands bordering the reservoirs in the Croton watershed, and in some locations a strip of land along the stream usually 100 ft. or more in width, and thus endeavor to keep polluting matter from reaching the reservoirs and streams. The legislature at that time passed a law preventing the acquirement of further lands for this purpose. It is estimated that if this former policy were followed throughout the Croton shed, many millions of dollars would be required for the purchase of such lands, and the city's taxes on lands, which are now about $450,000, would be greatly increased. During the past decade there has been an effort made to purchase land around the margin of all reservoirs, but to make no purchase along streams, and this policy was followed by the Board of Water Supply in connection with the Catskill supply. Such policy has been a very disappointing one to those who own lands which they desire to sell to the city at a much higher price than would be paid by private purchasers, and this desire to sell has caused some owners to increase the pollution in the hope that the city would be forced to buy such land. The city is required to furnish a property owner with the necessary facilities to dispose of sewage if the sewage cannot be disposed of on the land in question, but the property owner cannot impose an unnecessary expense on the city. The legislature has required the city to allow boating, fishing, and cutting of ice

on its reservoirs under such reasonable rules and regulations as may be conisdered necessary.

City Policy on Protecting Its Water Supply

The present city policy on protecting its water supply is affected by the legislation mentioned, and is outlined as follows:

a—Own land around the shore line of all reservoirs.

b—Prohibit by suitable rules and regulations the discharge of polluting material in such a manner as to threaten the contamination of the supply.

c—Discourage the establishment of institutions in the watershed which would house those who do not normally reside within the watershed limits.

d—Collect, treat and dispose of sewage from villages and from individual private property when necessary.

e—Require property owners to submit for approval plans for proposed sewage disposal systems which must later also receive the approval of the State Department of Health.

f—Supervise the maintenance and operation of private, factory and institutional sewage plants, and furnish chloride of lime to treat continuously and sterilize the sewage from the institutions.

g—Treat with chlorine all city operated sewage plant effluents, and to so treat a portion of the water before it reaches the reservoirs and all the water while in the aqueducts on its way to the consumers.

h—Treat with copper sulphate, distribution reservoirs when microscopic growths become troublesome, and also so treat the shallow bays and coves of the storage reservoirs.

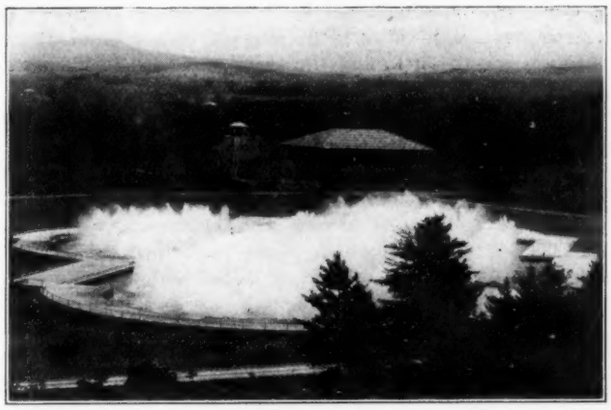
i—Frequently and regularly examine all parts of the watershed to see to it that any violations of the rules or regulations are promptly reported and speedily abated.

Organization to Safeguard Quality of Water Supply

The organization to watch over the purity and safety of the water supply and prevent the pollution thereof, is headed by an engineer who is an expert in sanitation as far as it relates to water. Under the engineer in charge in the Catskills there is a supervisory inspector, with seven inspectors, who cover the inhabited portions of the watershed by inspections which daily require some ten miles of walking by each man. Each inspector has a district within which routes are laid out, and the frequency with which each route is covered depends upon the sanitary importance of such route. Some important points are seen daily, but usually a week or more elapses between inspections. All cases of typhoid occurring on the watershed, of which there are usually about five yearly, are reported, blood tests made, and sterilization of discharges effected. A squad of sanitary laborers, with an auto truck, is assigned to correct all conditions reported by the inspectors, which cannot be remedied by them, and also to move toilets to new locations as remote as possible from the streams. In the Croton watershed, the organization is similar, except there are 2 supervisory inspectors over the 25 inspectors employed therein. All questions of sanitation that arise are handled as diplomatically as possible, and effort made to secure the co-operation of the property owners or tenants. This co-operation is usually obtained and there have been but few cases which have had to be referred to the corporation counsel for legal action.

Where sewage of human origin is present in sufficiently large volume to require other treatment than that afforded by a leaching cesspool, it is disposed of as far as possible by sub-surface tile drains, or open absorption trenches, and thus the sewage travels through many feet of soil before reaching the nearest stream. This cannot always be done, and there are two instances in the Croton system where sewage, after being purified and filtered, is treated with chlorine, and then discharged directly into the stream, which eventually discharges its waters into Croton Lake. The sewage so treated is practically sterile, and from a bacteriological viewpoint is better than the water supply which is furnished to many American cities and towns. The percentage of removal of B. coli, which is the typical intestinal bacteria used to determine the extent of pollution, averages over 99.9998 in these plants.

In the Catskill watershed the soil is generally unfavorable for rapid absorption of drainage water, and war has interfered with the department carrying out its plans to sewer certain communities and thus prevent sewage of human origin



THE ASHOKAN AERATOR FOUNTAIN, WHERE 375,000,000 GALS. PER DAY ARE SPRAYED INTO THE AIR TO RELEASE CONTAINED GASES AND DESTROY FRAGILE MICRO-ORGANISMS.

entering the Esopus creek and its tributaries above the Ashokan reservoir. There is, therefore, sewage now discharging into this creek and polluting the waters. At Phoenicia the department maintains a plant which introduces a solution of chlorine into the Esopus stream which destroys the bacteria. This plant is so located as to treat all water which is subject to such sewage pollution, and thus purifies the water before it enters the Ashokan reservoir. In the Croton valley there are several streams which pass through communities, so that incidental pollution cannot be avoided, and these are also treated with chlorine.

Chlorine Treatment of Water

The use of chlorine for treatment of water to destroy bacteria is a comparatively recent addition to the available safeguards for water supplies, as its use has developed almost wholly during the past decade, and is now the most important next to filtration. It can be obtained either in liquid form, or as hypochlorite of lime, which contains about 35 per cent. by weight of chlorine. It costs in the liquid form about 7 cts. per pound, and usually in the New York City supply only from one-tenth to two-tenths of a part per million by weight is used. This is equivalent to from 0.8 of a pound to 1.6 of a pound of chlorine for 1,000,000 gals. of water, or a cost for the chemical of about 10 cts per 1,000,000 gals. The amount of chlorine now used is so small that its presence cannot be detected by the most acute taste.

When chlorine was first used at Phoenicia several hundred trout and other small fish were killed, and immediately complaint was made to the State Conservation Commission. After a few days the dead fish ceased appearing, and subsequent experiments showed that the amount of chlorine applied could be reduced to an amount too small to affect even the most delicate fish. The trout are frequently seen swimming up to the treatment pipe and leaping over it, and indicating no diminished vigor from living in the chlorinated water.

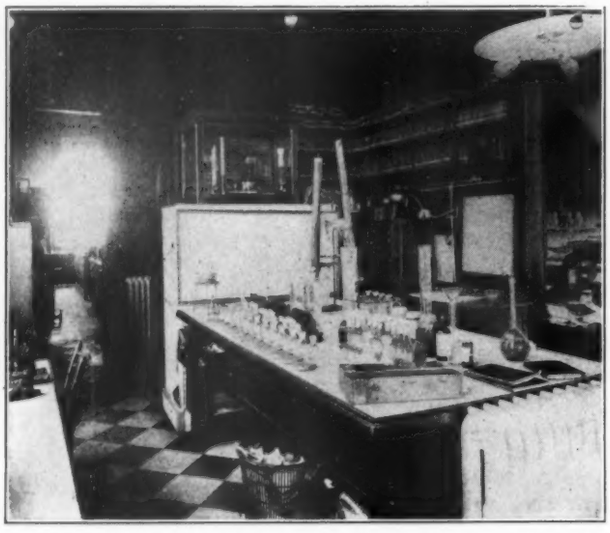
Treatment of Microscopic Plant Forms With Copper Sulphate

When water stands in reservoirs it may at any time and without previous warning, develop almost overnight microscopic growths, of which a number of forms are very objectionable, due to the disagreeable taste and odor produced thereby. The growths, which quite frequently multiply in the

New York supply, and the characteristic taste or odor, have been previously mentioned in this report. They are plant forms which have no effect on one's health, but it is hard to make the consumers believe this, and it must be admitted that their presence makes the water most objectionable. Fortunately, these plant forms are quickly killed by the addition of copper sulphate in as small a quantity as 1 lb. per 1,000,000 gals. of water. It is usually put in the water by placing the copper sulphate in a bag of porous material and dragging it through the water at the stern of a row-boat or small launch. The water treated should not be used for three or four days after the treatment, so as to permit the copper sulphate and the dead algae to settle and the taste and odor to disappear.

Storage

One of the very important safeguards that is available for New York's water supply is the long period of retention of the water in the immense reservoirs connected with the Catskill and Croton systems. In the Croton watershed there are 16 reservoirs and ponds having a total storage capacity of 104,400,000,000 gals., of which nearly one-third is stored in Croton lake. This vast volume of stored water is enough to provide New York with water for one year at the present rate of draft on the Croton system, even though not a single drop of water was added during the year. In the Catskills, the Ashokan reservoir has 130,000,000,000 gals., and at the present



THE BACTERIOLOGICAL ROOM OF THE MT. PROSPECT LABORATORY, BROOKLYN, WHERE THOUSANDS OF WATER SAMPLES ARE YEARLY EXAMINED.

rate of draft would last nearly one year. There is also the Kensico reservoir in the Catskill system, between the Ashokan reservoir and the city, holding about 30,000,000,000 gals. It is therefore reasonably certain that most of the water entering these reservoirs will remain therein for several months during which time disease bacteria will die from starvation, due to the general purity of the water. Also the dirt in the water will be almost wholly eliminated.

Aeration

The microscopic growths may develop in these reservoirs and also carbon dioxide gas may be present, which it is desirable to eliminate as far as possible. In the new Catskill system provision has been made for aerating the water by shooting it up in the air through nozzles, and thus forming enormous beautiful fountains. There is an aerator at both Ashokan and Kensico reservoirs, but, due to the greater head available, the fountain at Ashokan is the more impressive. The water does not need more oxygen, which it could obtain from this fountain action, but it is improved thereby through the liberation of contained gases and the breaking up of some of the more fragile of the micro-organisms.

The final act in making the water safe for the consumers is the treatment of all the water with chlorine while it is in the aqueducts, and flowing to the distribution reservoirs and pipes in the city. Liquid chlorine is used for both supplies, the Catskill water being treated at Kensico just after it leaves the reservoir and at a point about 12 miles from the city line, while Croton water is treated at Dunwoodie, about 4 miles from the city line. These plants are among the largest in the world, and daily treat some 600,000,000 gals. The water as it comes to these plants is usually in a condition that would be considered good for a domestic supply, but as no chance should be taken in safeguarding the lives of 6,000,000 people, this final treatment is given.

Typhoid Rates

The usual index of the purity of a water supply is the typhoid death rate of the community. In New York city the rate is now very low, as shown by the following comparison with the record of other cities having a population of over 500,000:

	Death rate per 100,000
Chicago	1.4
Boston	2.5
Philadelphia	3.0
New York	3.3
Cleveland	4.7
St. Louis	7.2
Pittsburgh	9.8
Detroit	10.0
Baltimore	12.2

It is considered certain that what typhoid does develop in New York is due to causes other than water supply. Charts are made of all cases reported, and some very interesting results have been found from studies of the local epidemics. Various causes have been found, such as typhoid carriers, milk contamination and ice cream contamination.

Very little need be said about the treatment of the supplies from the private water companies, as fortunately their source of supply is uniformly the water flowing through the saturated sands and gravels of Long Island, and the water is therefore naturally filtered and only need be guarded against contamination after it is drawn from the ground through the wells. This is the type of development of the supply used by all the private companies. A careful watch over the water furnished is maintained by the department force, and regular monthly examinations made of all supply works.

The Laboratories and Their Work

To determine the condition of the water and its contents, and also the effectiveness of protection from pollution and of the treatment applied to the various supplies, it is essential that there should be available well equipped laboratories, manned by experts who are constantly sampling and examining the various supplies. New York has three of these laboratories, the main one being at Mt. Prospect reservoir, Brooklyn, with branches at Mt. Kisco for the Croton system, and at Ashokan reservoir for the Catskill waters. Connected with these laboratories there are 16 men, and about 13,000 samples are examined yearly. At some nine points daily samples are taken, as these samples represent the supply furnished in the various sections of the city. The usual frequency of sampling varies from weekly to monthly. The results are sent to the operating and maintenance force who can call on the laboratory experts for aid in investigating any unusual problem which presents itself. The laboratory force undertakes a large amount of original research work as well as its regular routine work, and has to its credit many advances in the art of water examination and analysis.

Results Secured for New York City

Every hour of the day or night anyone in New York City can turn on the faucet and draw a glass of water which is certain to be safe from disease breeding germs and satisfac-

tory for either domestic or manufacturing use. This is due to the effective daily work of the many men employed by the city to make its water supply safe and the $166,000, spent yearly for protecting and treating the water is certainly giving excellent returns. How soon the city will demand the higher standard of a perfectly clean, clear water, free at all times from tastes and odors cannot be now determined. Filtration is the only way to secure this improvement, and as the public seems well satisfied with the supply now furnished, the expenditure of millions for filtration appears to be one that will not be undertaken for some years to come.

The present head of the Department of Water Supply, Gas and Electricity is Commissioner Nicholas J. Hayes, and the Chief Engineer of the Bureau of Water Supply is Merritt H. Smith.

Design Features and Form of Contract for Constructing a Large Earthen Water Supply Dam on Cost Plus Fee Basis

By Jacob L. Crane, Jr., and J. G. Kimmel, with Gannett, Seelye & Fleming, Consulting Engineers, Harrisburg and Erie, Pa.

On May 8, 1919, the Girard Water Co. of Pottsville, Pa., awarded a contract on the cost plus variable fee basis, for an earth fill dam and reservoir to be constructed on Whiskey Mill creek in Schuylkill county, Pennsylvania. The dam and reservoir, which will cost about $200,000, are to provide additional storage to tide the Water Company over the dry periods in summer and fall.

Layout and General Features of Water Works

The interesting layout of the water company property is shown on the accompanying map, Fig. 1. The sources of supply are Dresher's Run, upon which Reservoir No. 5 is located, Whiskey Mill creek, upon which there is a small intake connected with Reservoir No. 5 by a 16-in. gravity main, and Little Catawissa creek, upon which there is another small intake. The water of this latter creek is only used in times of drouth, the water being then pumped directly from the intake.

The water collected from these sources is pumped through the station shown just below Reservoir No. 5, against about 600 ft. head, to the top of Locust mountain into Reservoir No. 3, from which it runs into Reservoirs Nos. 2 and 4. From all three of these reservoirs it is distributed by gravity to the collieries and villages in the Shenandoah and Mahanoy valleys immediately to the south. The collieries and their connecting railroads take 86 per cent. of the water supplied by The Girard Water Company, only 14 per cent. being used for domestic purposes.

These valleys form the most productive part of the Southern Anthracite coal field, and the mining operations have made it impossible to collect surface or ground water in this area. In fact, the mining operations have extended to the top of Locust mountain, where a great stripping operation, begun in 1913, has almost entirely destroyed the watersheds formerly tributary to Reservoirs Nos. 2, 3 and 4, and will soon force the abandonment altogether of Reservoir No. 4, which is underlaid with valuable beds of coal. There is one bed of coal under Reservoirs Nos. 2 and 3, but this is comparatively thin, and the reservoirs are worth more for storage and distributing purposes than the coal. These factors drove The Girard Water Company over into the Catawissa Valley, which is purely an agricultural region, for its sources of supply, and in 1913 and 1914 the No. 5 reservoir and pumping station were built on Dresher's Run.

This reservoir impounds 312,000,000 gals., at spillway level from a watershed of only one square mile, with an average annual rainfall of 54 ins., and a mean run-off of about 45 per cent. The area of the reservoir is 41 acres and its maximum depth 51 ft., 6 ins. Reservoir No. 5, for which Mr. J. W. Ledoux of Philadelphia made the plans, is an earth fill structure with a concrete pavement on the upstream face and a cut-off wall of concrete and clay puddle at the upstream toe. The reservoir and dam, the stone house of the pumpman and the pumping station make a fine appearance as viewed from Locust mountain in the setting of this beautiful valley.

Pumping

The pumping station is equipped with three 5-stage centrifugal pumps, operating against a head of 583 ft., or a pressure of 273 lbs. per sq. inch. The pumps are driven by three 250-H.P. electric motors. A fourth unit has been ordered. With this the capacity of the plant will be 6,000,000 gals. per day. The pumps have given splendid service and up to January 1, 1919, showed but little loss of efficiency after being in operation since Sept. 16, 1914, a total of 25,710 pump hours. Since Nov. 1, 1918, however, it has been necessary to pump directly from the Little Catawissa creek, in order to conserve the supply of stored water, and as this was not contemplated when the plant was designed, the water does not pass through the screen pot, as does the water from Reservoir No. 5, nor is there an opportunity for the sediment in the water to settle. This has caused more wear to the pump parts in six months than in the previous 4 years. The use as a suction main of the long supply line from the Little Catawissa intake causes a considerable drop in the capacity of the pumps, as compared with their duty when pumping from Reservoir No. 5, from

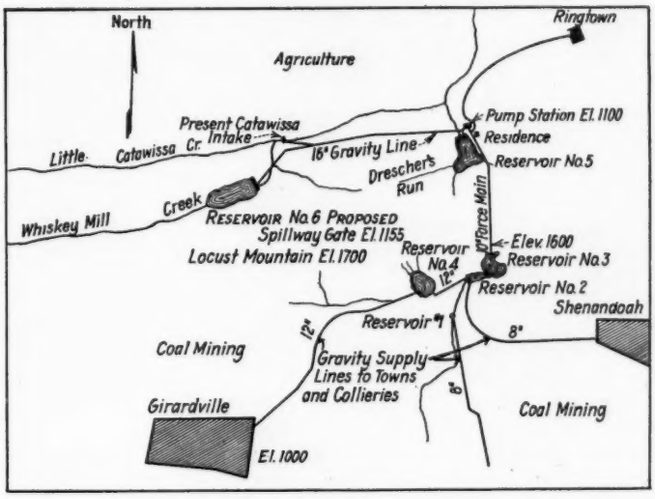


FIG. 1. MAP OF GIRARD WATER COMPANY'S RESERVOIRS AND PIPE LINES.

which water is supplied to the pumps above atmospheric pressure. The new reservoir, No. 6, will so increase the supply of stored water as to do away with the necessity of supplementing it from the Little Catawissa.

Consumption of Water

The demand for water from The Girard Water Company has increased very rapidly in recent years, as follows:

Year	Total Water Consumed
1912	444,729,136 gals.
1913	508,162,356 gals.
1914	471,287,900 gals.
1915	565,475,640 gals.
1916	830,404,236 gals.
1917	942,261,648 gals.
1918	1,057,487,984 gals.

In the studies for Dam No. 6, carefully drawn mass diagrams developed the fact that Reservoir No. 5, and the unstored waters of Whiskey Mill and Little Catawissa creeks would not provide sufficient water the year around to supply the demand in the immediate future. This is checked by the actual experience of the last four years, during which the

stored water has steadily decreased in volume. It therefore became necessary to store the water of Whiskey Mill Creek as soon as possible, to collect the high winter and spring run-off and so hold a larger available supply for the dry periods.

Design of Dam

On account of the high cost of material, delivered on the site, for a concrete or a masonry dam, an earth fill type was selected. Embankment material can be obtained from the south side of the reservoir with an average haul of 1,000 ft.

The cross section of the dam is shown in Fig. 2. It will be 850 ft. long at the crest, 246 ft. wide at the base, and have a maximum height of 50 ft. The upstream slope will be 2½ to 1, protected by a 15 ins. layer of hand-placed stone paving. The downstream slope is 2 to 1, with a 5 ft. berm half way down the slope. A concrete spillway, 30 ft. wide will be built at the south end of the dam, the crest of the spillway to be 5 ft. below the top of the dam.

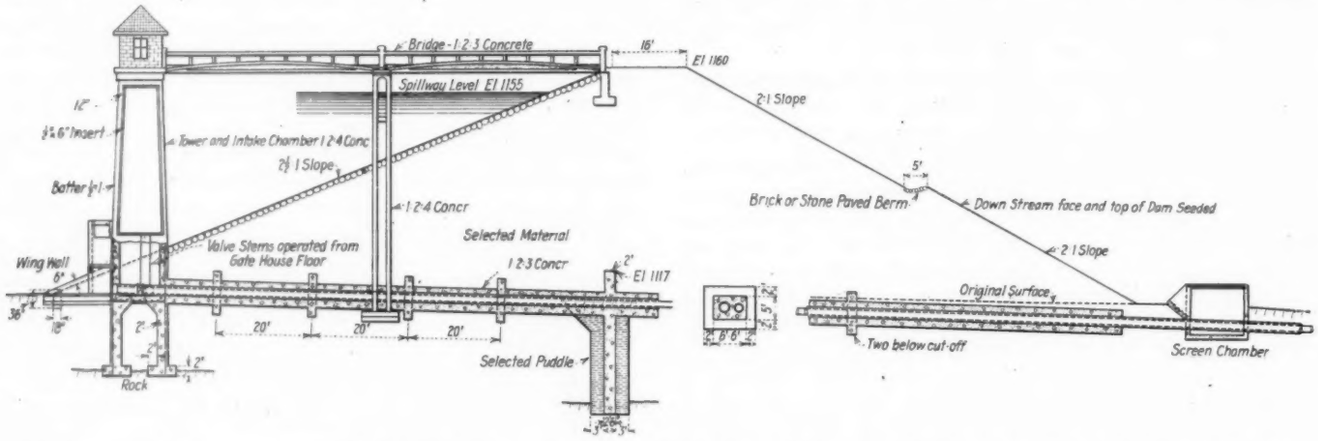


FIG. 2—CROSS SECTION OF THE EARTH FILL DAM OF THE GIRARD WATER CO. ON WHISKEY MILL CREEK, SCHUYLKILL COUNTY, PENNSYLVANIA.

A concrete cut-off wall with a 3 ft. puddle wall on each side, will extend from solid rock up into the dam about 3 ft. The bed rock in this vicinity is a broken, seamy, red shale. To reduce the loss of water through the foundation, this rock will be grouted under pressure to a depth of 25 ft. below the bottom of the cut-off wall.

The drainage area of the reservoir is about two square miles. The water area of the reservoir when full is 42 acres, and the capacity to spillway level is 270,000,000 gals.

Features of the dam are the concrete spillway and gate-tower bridge, which will add greatly to the appearance of the structure, at a minor increase in cost. The gate-tower will be of concrete, but the house surmounting it of gray mountain stone.

Form of Contract

In the spring and summer of 1918, Gannett, Seelye & Fleming designed and supervised construction of a bridge and a dam on the cost plus a fixed percentage fee basis. Subsequently they were engaged on government work on which construction was carried out under various cost plus contracts, and with much previous experience of the weaknesses of the old set unit-price contract, it was decided to draw a contract for this work on the cost plus variable fee basis, but in such a way as to allow the greatest scope for competitive bidding, to protect the owner from any loss by an irresponsible contractor, while the owner assumes all normal risk in the place of the contractor, and to secure precisely the desired job at the lowest possible construction cost. Much interest has been shown in the contract and it has received commendation from many engineers and contractors who have seen it.

The contract, under which payment is made for the actual cost of the work, plus a fee, with a bonus and penalty for under-run and over-run of estimated cost, respectively, may be outlined as follows: An accurate account of the actual cost, segregated as to different items of the work, is to be kept jointly by the engineer and the contractor, and the latter is to be paid this actual cost, which includes everything immediately connected with the work, but excludes home office expense, interest on funds used, and all overhead, except that actually incurred in the field. Monthly payments are to be made to the contractor of the actual cost for which he has made approved bona fide disbursements, plus 3 per cent. on account of fee.

The contractor's proposal and contract give unit estimated costs and a total estimated cost for the work, a percentage of the total estimated cost as fee for the construction, a time within which he agrees to complete the work (with a penalty for liquidated damages of $40 per day for exceeding that time), a complete statement of experience and qualifications, and a list of equipment to be used on the job, with total rental prices at which the plant is to be furnished for the entire construction.

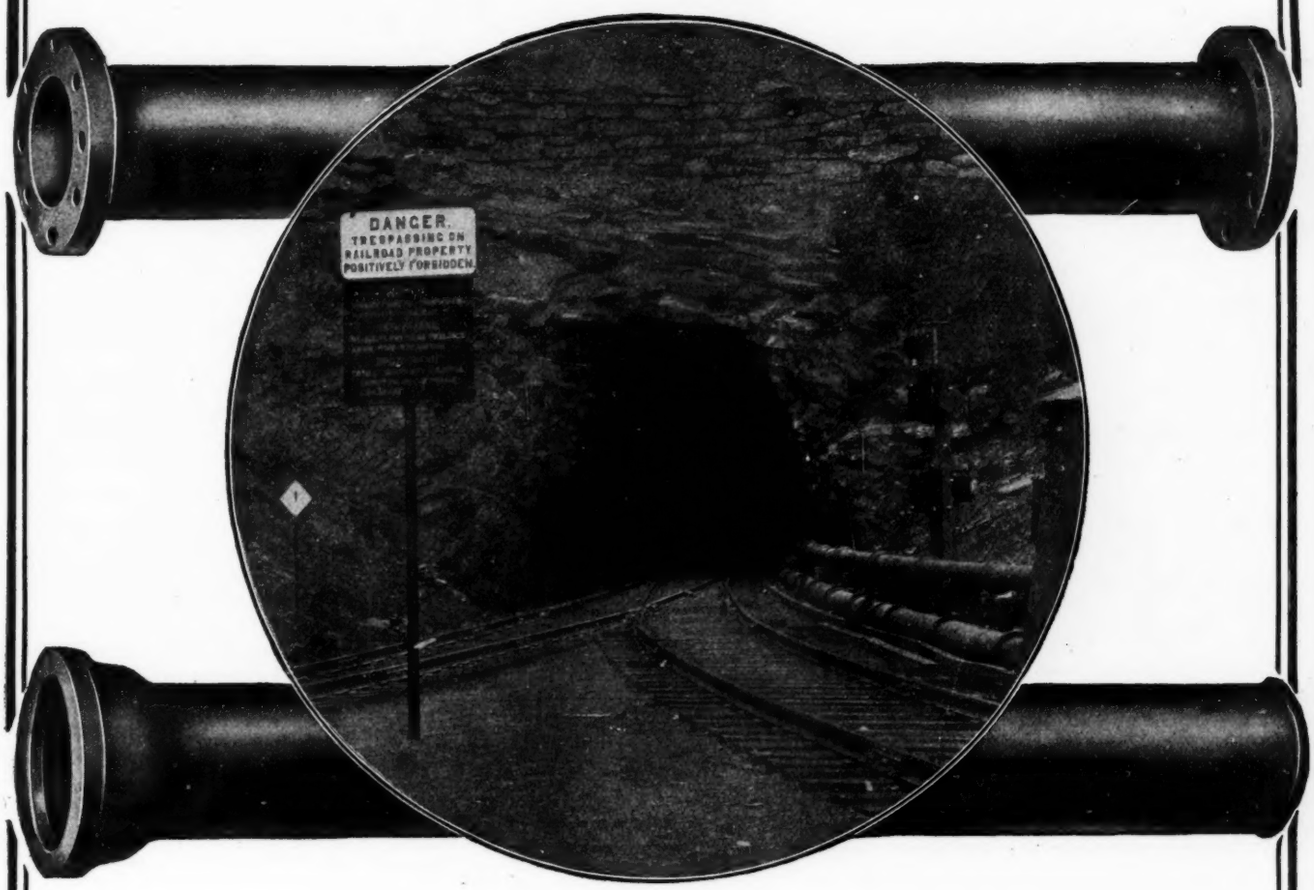
At the close of the work the contractor's total fee is determined as follows: With the actual quantities of work completed and the estimated unit prices bid, a corrected estimated cost is made up. If the actual cost is then less than this corrected estimated cost the contractor receives his bid percentage fee of the corrected estimated cost plus one-quarter of the saving up to $10,000 and one-half of all saving above $10,000. If the actual cost is greater than the corrected estimated cost, the fee is reduced by one-quarter of the excess up to $10,000 and by one-half of all excess over $10,000, but in no case can the fee be less than 3 per cent. of the corrected estimated cost after deductions have been made of penalties for overtime and for excess cost.

Twenty-Three Bids Received

The bids were opened on May 5, 1919, 23 proposals having been received. Ample opportunity to look over the work and to get complete information on the contract and specifications were given to all interested contractors, and there was an unusual amount of interest evinced in the work. A schedule for rating the proposals was drawn up before the opening of bids, and the best proposal selected on the basis of (1) Estimated Cost, (2) Qualifications, (3) Fee, (4) Time for Completion and (5) Equipment Rental.

The bids ranged in estimated cost from $160,000 to $450,000, with eight bids of $200,000 or less, and four between $160,000 and $185,000. The engineers' estimated cost was $175,000. On the basis above outlined the Central Construction Corporation of Harrisburg, Pa., was chosen to do the work, its estimated

"Danger"



This warning has no connection with the lines of cast iron bell and spigot and flanged pipe shown in the picture.

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cost being $170,530; fee, 10 per cent.; time, 175 working days, and equipment rental, $20,875.

If this form of contract is as satisfactory on the construction as it has been in securing bids and selecting a contractor, it will demonstrate its great usefulness. In the meantime, it appears that much greater responsibility is rightly placed upon the engineer, that the owner has probably been saved not less than $10,000 on this job, and that a contract for the work more nearly just to both owner and contractor has been put into effect.

It is interesting to note that the Girard Estate, of which The Girard Water Company is a subsidiary corporation, was bequeathed to the City of Philadelphia by Stephen Girard, the income to be devoted entirely to the support of Girard College, a splendid philanthropic institution in Philadelphia maintained for the education of orphan boys between 10 and 18 years of age. The estate is administered by the Board of Directors of City Trusts, who are appointed by the judges of the Courts of Common Pleas of Philadelphia and who serve without compensation. Five of these constitute the Board of Directors of The Girard Water Company.

James Archibald is mining engineer of the Girard Estate and general manager of The Girard Water Company, with offices at Pottsville, Pa. Gannett, Seelye & Fleming of Harrisburg and Erie, Pa., are engineers on Dam No. 6, with the authors as principal assistant engineer and as designing and supervising engineer, respectively.

The Distribution of Water

By Edward E. Wall, Water Commissioner, Department of Public Utilities, 312 City Hall, St. Louis, Mo.

The distribution system of a water works gives more food for thought to the chief than any other division of the department, and less has been said or written about it than any other by technical men. This is not because it is of less importance, nor that it is uninteresting, nor that its problems are easier of solution than those pertaining to power or purification plants. The distribution force has to deal with the unthinking, and, therefore, unreasonable public on all questions of lack of pressure and quantity, deterioration in quality, disputed assessments of rates, incorrect meters, water waste and other major and minor troubles.

Both pressure and quantity cannot be maintained the same throughout the area supplied by any water works for the obvious reason of differences in elevation, or if the territory be approximately level, as in the lake cities, then distances from the pumping stations and the increasing losses by friction curtail both pressure and quantity to the residences of the outlying districts. Again, during the hours of greatest consumption those nearest the source of supply, using water wantonly and recklessly, deprive the far-away consumer of his just deserts. Despite these irremediable causes of and reasons for annoyance and inconvenience to the consumer, it is not always possible for the distribution office to convince him that he is the victim of circumstances over which neither he nor the office have control and that his condition is similar to those occurrences that are referred to as "visitations of Providence," and must be endured with as much patience as the victim can muster. If it is any consolation to him, he can justly blame the more fortunate consumer on lower ground or nearer the works, who is wasting the water that complainant needs so badly. This being a rather unsatisfactory procedure because it is so impersonal, the aggrieved citizen prefers to visit his wrath on the unfortunate employe of the water works, who represents to him the institution in person.

It is evident that it is humanly impossible to design a system of distributing pipe that will successfully meet all conditions of consumption and maintain an equality of pressure, when corrected for differences of elevation, unless all pipes were made many sizes too large for any possible demand, which is utterly impracticable.

In all probability, as long as water is distributed through pipes under pressure, the water works man will have to listen to complaining consumers and patiently expound to unbelieving ears the mathematical reasons why water will not flow at all times on the second or third floors of houses built on hilltops.

On account of the continually increasing consumption and waste of water as the northern portion of the city of St. Louis built up, in the southern part of the city pressure conditions gradually became worse until it became necessary in 1916 to lay a 36-in. main from the pumping station a distance of about 27,000 ft., to connect directly with the mains supplying the southern district. This 36-in. main had no connections with the distribution system throughout its entire length, and served solely as an outlet for one 20,000,000-gal. pump, which was operated at a pressure sufficiently high to increase the pressure in the southern district at least 10 lbs. during the hours of greatest consumption. It was found that pressures could be kept normal by operating this pump from six to eight hours per day during the seasons of greatest consumption.

Another fertile source of aggravation comes from the extreme delicacy of the sensory nerves of some people, who continuously discover strange odors and tastes in the water. Although tests of samples taken from their faucets fail to show any evidences of the presence of foreign matter, and although they can produce no sample of water taken from their own houses in which an unprejudiced person can find objectionable odor or taste, they remain unconvinced of their error and bob up serenely on some later date with the same complaint. We have had people swear they could taste alum in the water, when there was not a pound of alum in the whole works and when there had not been any on the premises anywhere for a year. Others have been positive that they could detect the presence of lime in the water and that it was ruining their stomachs, when it could be proven by chemical analysis not only that there was less lime in the treated water than in the river water, but that the lime that was left in the treated water was in such a form as to be absolutely harmless to the human system. And so on to the end of the chapter as to the smell and taste of the water.

If it were possible for the water works of any city to supply the people with water from the River of Life which flows through Paradise, still there would be consumers who would find fault with it.

When St. Louis was supplied with water of which Mark Twain said, "Every tumblerful of it holds an acre of land in solution," but little complaint was heard as to odor or taste, for they had been using it for 75 years, but as soon as it was clarified, purified, filtered, sterilized and delivered to them sparklingly clear, large numbers of the population immediately developed a fastidiousness bordering on the miraculous.

To attempt to enumerate the varieties of dissatisfaction which are brought to the office, where water bills are paid, would require more time and space than either the writer or editor could spare. It is one of the remarkable frailties of human nature that the mere possession of a bill for water in many instances produces a sort of temporary aberration and so obscures the memory that the number and class of fixtures in one's residence becomes but vague and hazy recollections, and the faculty of distinguishing truth from falsehood is suspended from action for the time being. Under the obsession produced by the presence of a bill for water, people have been known to do strange things. Garden hose have been stored in baby carriages or gas ovens; water-power washing machines hidden in the coal bin or stable; automobiles have changed owners over night; live stock has utterly vanished in a day, to reappear later; until an experienced inspector develops an uncanny fac-

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D—Getting the dirt back is sometimes as troublesome and costly as getting it out. This machine makes it easy and does it in a hurry on one man's time. Just the outfit for city streets where work must be done with uniformity and dispatch. The P & H Backfiller has capacity to take care of the largest sizes of trench excavators.

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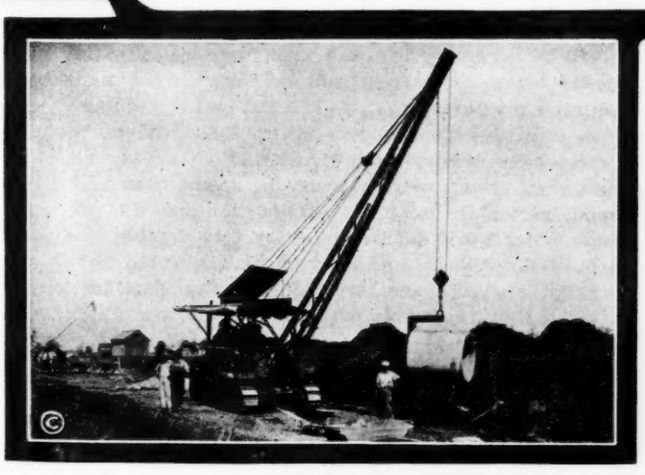

ulty of discovering these lapses from righteousness, as though he was gifted with second sight.

No better field for observing the littleness of human nature could be found than is afforded the water inspector in the daily round of his duties. Such a position should be very attractive to a man of keen observation with an eye for the unusual and a saving sense of humor, for the enjoyment to be derived out of the job would far outweigh the lack of proper remuneration for a person of his type.

It is distressing to discover the lack of faith many people have in the accuracy of an instrument so scientifically designed and as carefully constructed as a water meter. Hundreds of consumers are positive that their personal judgment as to the quantity of water used on their premises is more to be trusted than the registration of the meter. In general, a water meter is like a watch, bearing the truth on its face. Occasionally one goes wrong or fails to register; so do watches, but people as a rule do not distrust watches or look upon their faces with suspicion. One reason for the unpopularity of meters lies in the dislike which most people have of being reminded of their carelessness or extravagance by a conscienceless contrivance without brains and with which no argument is possible.

Consumers cannot be made to believe that a leaking faucet will waste 200 gals. of water per day or that a garden hose playing on the lawn will deliver more than that quantity per hour.

The same quirk in the human mind that leads people to buy goods at excessive prices on time payments, prevents the average man from comprehending that he indirectly pays far more for water waste in having to provide funds for new pumps and larger mains to meet growing consumption, than any number of plumbing bills he is likely to have to pay in repairing leaking pipe and fixtures. The gradual increase in his water bills as he and his fellows permit and ignore the reckless waste of water sold under flat rates, does not annoy him nearly so much as would the presence of a meter reminding him of the obligation to stop all leaks in his plumbing and keeping before him the knowledge that every gallon of water drawn on his premises was measured and recorded against him. By and by, when water meters are universally used in all cities and towns, he will accept the change almost unconsciously and forget that he ever aggravated a water works superintendent by advocating a flat rate.

As the character of localities changes in a growing city, the water mains which were ample for residences and small buildings become altogether inadequate for a congested district, dotted with office buildings and wholesale and retail establishments occupying buildings several stories in height.

In the meantime, below the surface of the street there is crowded tightly a tangle of conduits, tunnels, pipes, cables, etc., until it is hardly possible to tap or connect to the gas and water mains which were originally the sole occupants of the underground territory.

To replace the old main with a larger one, to supply the increasing demand for water for office use, for manufacturing and for private fire systems, is so difficult a task as to force the distribution engineer to lay feeders on cross-streets, enlarge mains on parallel streets, and to use alleys whenever possible, before considering the project of entering upon the crowded underground area to lay a new main.

Now, that it is possible easily to measure and record the flow through a pipe, a survey of the mains in any district sometimes brings out some startling facts, for example a main laid with the intention of serving as a feeder into a conjested district may be carrying less than one-fourth its capacity during the hours of heaviest consumption, while some smaller main not intended as a feeder will be carrying its full capacity all the time. Such a survey at once shows where a distribution system needs reinforcement and eliminates all guess-work and fixing sizes of pipe-lines from an inspection of the map.

The great mass of detail involved in the administration of the affairs of the distribution system of any water works, covers an extensive field outside of the difficulties arising from dealings with consumers. Some man with a penchant for writing books might consider the compilation of a decently sized volume on the subject, and he could doubtless find ample material through correspondence with superintendents and engineers experienced in water works operation.

Curtailing Water Waste and Fixing Equitable Rates at Sault Ste. Marie, Michigan

By W. M. Rich, City Manager, Sault Ste. Marie, Mich.

The Sault Ste. Marie water works are owned and operated by the City. The Pumping Station is located on the St. Mary's river about four miles west of the heart of the City.

Elements of the Plant

The plant consists of two-5,000,000 gal. Holly steam pumps and two-150 H. P. Morrison suspension boilers. The pumps have been in service 16 years, and are in very good condition except for the wear and tear that would naturally occur in that length of time.

The intake crib is located on the south channel bank of the St. Mary's River about 1,500 ft. from the shore, in approximately 32 ft. of water. The intake pipe is 36 ins. in diameter, and is laid deep enough to feed the pump well by gravity. The water may be pumped either from the well or from the intake pipe direct.

The pumps discharge into a 24 in. main leading to the City. This discharge pipe is equipped with a Venturi meter and a register-indicator-recorder instrument supplied by the Builders Iron Foundry.

Water is Chlorinated

From the above description it will be noted that there is no question about the abundance of the water supply. However, as to its purity, there is a potential danger of contamination owing to the great traffic that plies the river during eight months of the year. Then, too, during the spring when the ice is going out there is danger of pollution and again in September, when the surface waters from the large areas draining into Lake Superior begin to be felt. To overcome any possible danger from contamination of the water from any of the above mentioned sources, we have installed a solution feed, automatic control, chlorinator. We have equipped a laboratory where daily tests of the water are made, and in this manner every precaution is taken to protect the health of the people.

Since the chlorinator was installed, which was about 14 months ago, there has been only one case of typhoid fever contracted in the City, and in tracing the case, we learned positively that it could not be attributed to the water.

This, in a general way describes the pumping station of the Sault Ste. Marie water works. In the following discussion it will be necessary to touch upon the local situation at the Soo to bring out certain points in regard to maintenance, operation, rates, etc.

In dealing with a modern water works system, there is a great variety of features that enter into its make up, and in discussing briefly such a plant as operated municipally, it would be well to adopt a classification for this discussion. While water works plants may vary considerably in different parts of the country and suggestions applicable to one plant may not apply to another, the following classification will fit very nicely the plants with which I am most familiar.

Physical Features of a Water System

The physical features of a water works system may be broadly divided into supply to pumps, pumping station, water mains, service connections and meter services. In a plant such as the one at the Soo, the supply to pumps simply in-

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cludes the intake, the pump well and the chlorinator. However, in some other plants, the supply to pumps department would have to be subdivided and embrace sedimentation tanks, sand fillers, softening apparatus, etc. The pumping station, service connections and meter services would not vary materially in any water works system, but in some cases the water mains would have to include stand pipes and reservoirs.

Municipal Ownership Not Always a Bar to Efficiency

In addition to the physical features of a water works system, we have the department for taking care of the revenue collections and the department to provide for interest and retirement of bonds. In my opinion these last two divisions in the classification are very important, and right here is where the danger lies when a water works system is opened and operated by a municipality. It is a very unfortunate state of affairs, but it is true, nevertheless, that when a plant is municipally operated there is a tendency to make a political football out of it and at each change of administration there is generally a change in all the important offices in the department. As a consequence there is no fixed responsibility or authority, the revenue collections are neglected, rates are not adjusted to meet conditions, and in many instances the funds for retiring bonds are lost sight of completely. In order to make a success of the system the business must be conducted in the same manner as if it were privately owned. There must be some one person to hold responsible and the authority must be undivided. Under the Commission-Manager Plan of City Government, this system of conducting a water works system is possible and there is absolutely no reason why the system should not be as profitable an enterprise as if it were conducted privately.

Budget System and Accounting

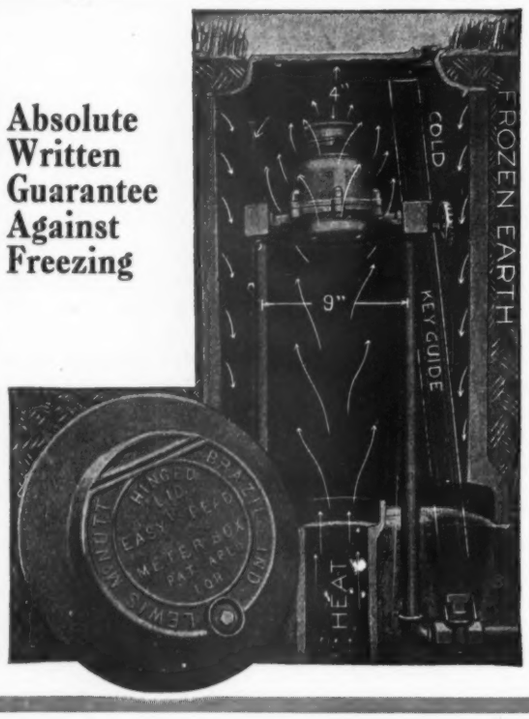
In order to operate a municipal water works system successfully, a budget system must be adopted and strictly adhered to. The costs of operation and maintenance must be very carefully kept and from these records the question of proper rates determined. As an example of the budget system as applied to the Soo Water Department, the classification as previously outlined takes care of each division very adequately.

These divisions are themselves divided into expense and capital outlay accounts according to the budget classification. Expense comprises all items of expenditures necessarily incurred for current administration, operation ond maintenance of the several departments; those which the funds are reimbursed; and those for materials and equipment in the nature of renewals or replacements, which do not add to the capital assets of the corporation. The Expense Classification is in turn divided into Personal Service Expense, which is direct labor of persons in the regular or temporary employment of the corporation not chargable to capital outlay; Contractual Services, which are activities performed under express or implied agreement, inviting personal service plus the use of equipment or furnishing of commodities; operating supplies expense, which are commodities of a nature which after use show a material change in, or an appreciable impairment of, their physical condition and rapid depreciation; materials for maintenance expense, which are commodities of a permanent nature in a new, unfinished or finished state, entering into the construction, renewal, replacement or repair of any land, building, structure or equipment; and capital expense and contribution, which consists of rent, taxes, insurance, interest, retirement of bonds, contributions and pensions.

Capital outlay includes all expenditures which increase the capital assests of the corporation. This includes land and land improvement, buildings and public improvements, teaming equipment motor vehicles, furniture and fixtures, and any other additions to equipment which may be necessary and useful in the operation of the corporation, and which may be used repeatedly without appreciable impairment of their physical condition and having a calculable period of serivce.

In arranging the budget for the year all of these accounts are taken into consideration and the total appropriation carefully prepared. The receipts are also carefully estimated and the estimated surplus is thrown into the departmental division for interest and retirement of bonds.

The need for accurately accounting for the expenditures of the funds of a water works system is obviously greater now than at any previous time; owing to the fact that the cost of everything entering into the operation and maintenance of the system has greatly increased in the last 2 or 3 years, while in most cases the water rates have remained the same, or if



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they have been raised at all, have not been raised sufficiently to offset the greatly increased cost.

Water Waste

Because of the increased cost of operation and maintenance it is more important than ever that the great wastage that occurs in practically all of the American cities be stopped. I think I will be borne out in the statement that in the majority of cities a large proportion of the water that leaves the pumping station never performs any useful work. Some of it is wasted through the ground owing to poor construction of the mains and service connections, some is wasted through faulty plumbing and carelessness af the consumer where there is no meter, and in some cases a considerable amount of water is wasted in the winter time where it is necessary to leave the faucets open to prevent freezing. All of this wastage means a great loss to a city financially, besides reducing the pressure and causing a diminution of the supply available for fighting fires.

In my opinion too much stress cannot be laid upon the wastage and leakage of water. It is a comparatively easy matter to detect and repair the larger proportion of the leaks in the distribution system by means of a systematic and comprehensive survey and the use of suitable equipment for the purpose of detecting leaks. The stopping of the waste of water by a thoughtless public is however a much more difficult matter. Where a great number of the domestic consumers are on a flat rate, it has been the custom in the past to make a house-to-house inspection and instruct the public in the correct use of water. This is not particularly successful, though, because wastage stopped today may begin again soon and probably continue until the next inspection.

I do not mean to say that the majority of the people deliberately waste water, but I do know that they don't realize what a small leak will amount to in 24 hours and consequently do not give the matter much thought. The only practical method of stopping excessive waste is to install meters on all services.

Universal Metering

The reasons for metering all services are two-fold: First, because it is the only fair and equitable way to sell water; and second, because it is the only practical way in which to prevent waste. Where cities have been completely metered, it has been found that the introduction of meters has been a great success in checking the waste.

Fair Meter Rates

Once a city has started out on a definite program of metering all services, it is confronted with the problem of determining a fair and equitable meter rate. As an example of what this problem amounts to, I will give a brief discussion on the conditions existing in Sault Ste. Marie at the time the Commission-Manager Plan of Government went into effect and we were confronted with the fact that owing to the increased costs, the revenue from the water works department ceased to be sufficient to meet operating and maintenance costs.

Practically all of the large consumers of water were metered at that time and a number of the residences, amounting in all to about 10 per cent. of the total number of services. No study had ever been made, however, of the probable legitimate use of water as compared with the total amount pumped. A careful study was made in order to determine as accurately as possible just what the distribution was and an effort made to secure information that would enable us to adopt rates that would be fair to all. The average daily pumpage was approximately 3,500,000 gals., or based on a population of 14,500, amounted to 240 gals. per capita daily. This average daily pumpage has been reduced to 3,000,000 gals., or 207 gals. per capita daily. This latter figure is too high, but it proves conclusively that the leaks and wastage are being stopped. After determining approximately the amount of water that should

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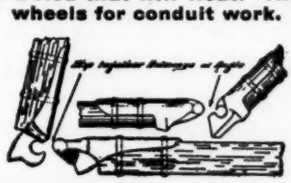

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be used, I found that over 50 per cent. of this amount was consumed by manufacturing and industrial plants.

With the information obtained, a careful study was made to determine upon a schedule of fair rates chargeable for metered services. The meter rates finally decided upon were based upon the New England Water Works Association form of rate. The schedule recognizes the principal of the sliding scale and provides three rates for users up to 1,000,000 cu. ft. per quarter. For consumers using over 1,000,000 cu. ft. per quarter, a straight rate per 100 cu. ft. is provided.

In addition a service charge is provided which is for the privilege of having a service, but does not include the use of any water. The service charge is an alternative for the minimum rate and represents a more logical and just arrangement. Under the service charge a specific amount is collected for the service and meter, this amount being collected regardless of whether any water is drawn or not. If water is drawn it is charged for and the amount charged for water used is added to the amount of the service charge.

The Service Charge

The service charge is made up of the following items:

First, a sum per annum representing approximately the cost of reading the meters, keeping the records, making out the bills, etc. For meters read quarterly, it is estimated that $1 per annum is a sufficient allowance.

Second, an amount which will represent the approximate value of water which passes a meter without being registered. The amount lost per service will range from nothing to 13 cu. ft. per day for a ⅝-in. meter. On this basis a charge of $2 per annum is allowed for a ⅝-in. meter. The charges for the large meters are proportional to their relative capacities.

Third, an amount which will give a reasonable return on the money invested in the service and the meter. It is estimated that 10 per cent. is a fair allowance for the depreciation in the service pipe and meter, and for the interest on the money invested in them.

The Rates Adopted

The rates arrived at for the sale of water in the Soo, to meet the local conditions, are as follows:

Domestic rate, up to 10,000 cu. ft. per quarter—9c per 100 cu. ft.

Intermediate rate, 10,000 to 100,000 cu. ft. per quarter—7c per 100 cu. ft.

Manufacturing rate, 100,000 to 1,000,000 cu. ft. per quarter—5c per 100 cu. ft.

Over 1,000,000 cu. ft. per quarter, 5c per 100 cu. ft., straight.

The new schedule of rates is working out very nicely and there was very little criticism from the public, even though the meter rates were increased over the old rates, owing to the service charge.

In this paper I have purposely avoided the engineering features of a water works system, owing to the fact that I consider the problem of stopping wastage and the fixing of equitable rates of prime importance. Of course I do not mean to say that the engineering is not important, but I do feel that good engineering is much more easily obtained than the prevention of waste and the fixing of equitable rates.

The foregoing paper was presented at the recent annual convention of the League of Michigan Municipalities.

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Relation Between Water Works Improvements and Fire Insurance Rates

By Kelsey L. Walling, Publisher, Iowa Insurance Service Bureau, Des Moines, Iowa.

The word "improvements" implies a condition in which perfection in the water works department has not been attained, and as each city has its own independent problems, we can only speak in generalities of desirable conditions.

Classifying a City for Insurance Rating.

The classification of a city for the purpose of insurance rating is dependent upon the efficiency not only of the water works but also the fire department, condition of the streets, the general character and construction of buildings, and the enforcement of proper ordinances. With a very few exceptions, the towns and cities of Iowa were classified under the rules of the Western Union Schedule which has been applied generally in the middle and western states. Recently we have adopted the Standard Grading Schedule of the National Board of Fire Underwriters, but as yet have applied it in only a few instances. This schedule, which brings practically the same results as the former treatment, although more technical in its application, is more susceptible to easy analysis in many of the details. Further reference will be made to this schedule later on.

Requirements for Water Works Protection in First Class City

The requirements for water works protection may be briefly outlined as follows:

Source—To be unfailing. If unreliable, a storage basin should be provided.

System—First, gravity system: supply from an unfailing source with impounding capacity of at least 30 days average domestic consumption. Second, combined system, the combined capacity of a reservoir or standpipe and pumps to be 100% greater than the total of the maximum daily consumption and the estimated fire flow. Third—direct pumping system: pumping capacity to be 100% greater than the total of the maximum daily domestic consumption and the estimated fire flow.

Boilers—To be equal in capacity to that of the pumps. Boiler feed pumps, injectors and steam pipes to pumps to be in duplicate.

Pump House—To be of fire-resistive construction and secure from inundation. Station to be equipped with a recording water pressure gauge.

Filtering Plant—If any, to have a capacity equal to the maximum daily domestic consumption and estimated fire flow unless pumps have direct connection to source of supply or unless the clear water basin has a capacity of at least one day's maximum domestic consumption.

Pressure—Pressure at pumping station or elevation of reservoir or height of standpipe should be sufficient to force the required fire flow over the highest buildings, unless fire department is provided with steamers.

Fire Flow—The estimated required fire flow ranges in accordance with the population. From 1,000 gals. per minute for a population of 1,000 inhabitants to about 9,000 gals. per minute for 70 or 75 thousands population. These figures are furnished by a table and are approximate only, the definite amounts to be determined upon inspection—considering the compactness and height of the buildings and values to be protected.

Mains—Main arteries should be ample in size to carry with moderate frictional loss, the domestic and fire consumption, and should be in duplicate. Mains in the business center and congested manufacturing district should be less than 10 ins. in diameter with 8 in. cross-connecting mains and in the residential section, not less than 8 ins. in diameter with 6 in. cross-connecting mains. Sufficient large feeders should be provided for all sections of the town, insuring suitable circulation, and all systems should be free from dead ends. No smaller mains than 6 ins. in diameter are recommended.

Gate Valves—Gate valves to be located at points so that it will not be necessary to shut off service more than the length of one block in the congested districts or more than two blocks in the residential districts. All branch connections to hydrants should be provided with gate valves.

Hydrants—To be "staggered" and should be located from 150 to 300 ft. apart in the mercantile and manufacturing district and from 300 to 600 ft. apart in the residential district. Hydrants should have no less than 2½ in. outlet and a steamer connection where steamer service is available. Street connections and riser for hydrant should not be less than 6 ins. in diameter. Hydrants and threads on outlets to conform with the National Standard.

High Pressure System—Water works system to be augmented by a separate system of high pressure pumps and mains to be utilized at times of fire and to carry sufficient pressure for direct fire fighting.

Records—Daily statement of consumption and pressure should be made and complete records of pipe, valves, hydrants, etc., to be kept in fireproof vault.

This, in brief, is an outline of the standard requirements for a first class city insofar as the water works department is concerned. The grading for second, third and fourth class cities are for the most part percentages of the requirements for the first class protection. Therefore, any improvements tending to increase the capacities of pumps, pipes, boilers, etc. so as to meet the domestic consumption plus the fire flow will result in better grading of the protection afforded by the water works department.

Of the cities of Iowa, Davenport leads with a second class grading. Several cities have been graded as third class, while the majority of the water works towns, as is also the case in most states, are fourth class.

Requirements for City of Third Class

In a city of the 3rd class, the source of water supply should be standard, or unfailing. The system at least 50% of standard; pump house, substantial brick construction, unexposed; boilers, standard, except that duplicate steam pipes to pump are not necessary; filtering plant, if any, 50% of standard; pressure and fire flow, standard; mains, in business and manufacturing district not less than 8 in. with 6 in. cross-connecting mains, and should have sufficiently large feeders to supply suitable circulation for domestic consumption and fire flow, but not necessary to have force mains in duplicate. From this it will be seen that any city having properly fulfilled the requirements for third class may secure a better grading by providing duplicate force mains and boilers and pumps for reserve purposes, which would increase the reliability of the system. The system in a third class town merely meets the conditions of domestic consumption and fire flow. Less than that would be three and one-half or fourth class, while better would be two and one-half or better according to the percentage of pumping capacity, boilers and mains in reserve.

The foregoing briefly outlines the standards to be desired for a first class city, and by variation of efficiency from that standard for second, third and fourth class cities, which comprise the whole list of water works towns.

Some Specific Information on Reduction of Fire Rates with Improvement to Water Works

We now come to the relation between water works improvements and fire insurance rates. As the water works is the only one department considered in the classification of towns or cities it must be treated in conjunction with the fire department; public fire alarms system; building and general ordinances and streets.

For the purpose of comparison, a one-story brick building in a 4th class town takes a basis rate of 30 cts. In a 3rd class town, 35 cts.; in a 2nd class town, 31 cts.

A one-story frame building in a 4th class town takes a basis rate of 77 cts. In a 3rd class town 71 cts. In a 2nd class town 67 cts.

The difference in the basis rates between the several classes will figure 13% on brick or fireproof buildings and 8% on frame buildings.

I have referred to the Standard Grading Schedule of the National Board of Fire Underwriters as one we have adopted for future use. This schedule is based upon the plan of an assumed number of points of variance from established standards.

The total points of deficiency is 5,000, allotted in accordance with their relative values as follows:

	Relative Values	*Points*
Water Supply	Engine Stream Basis	1,700
	Hose Stream Basis	2,000
Fire Dept.	Engine Stream Basis	1,500
	Hose Stream Basis	1,200
Fire Alarm		550
Police		50
Building Laws		200
Hazards		300
Structural Conditions		700
Total		5,000

The deficiencies chargeable to the water works may not exceed 1,700 points. These charges are made on the conditions of variance from standards which by experience and calculation are considered necessary for character and congestion of the buildings, areas of built up section and population.

Points of Water Works Deficiency

These points of deficiency are sub-divided under the following headings which will be referred to briefly and without analysis.

1. Appointment: Employees on municipal systems to be under civil service rules with tenure of office secure.

2. Chief Executive: To be competent and qualified by experience.

3. Records or plans: Records and plans of the physical structure and system to be complete, safely filed, in duplicate indexed and up-to-date.

4. Emergency Crews: To be on duty at all times or quickly available. An emergency wagon with necessary tools to be provided. At least one employee familiar with the system should respond to fire alarms in mercantile districts and second alarms elsewhere.

5. Alarms: To be installed in department quarters, in pumping stations, and where pressures are raised for hydrant streams, duplicate alarm circuits as to stations.

6. Adequacy: as regards capacity of source and supply works to deliver required supply. In calculating the deficiency under this item results obtained under fire flow tests in most favorable location are used. Ten hours fire flow in addition to the maximum domestic consumption is desirable in towns of over 2,500 population.

7. Reliability of source of supply: As may be affected by forest fires, floods, ice dams, shifting or channels, condition of intake.

8. Reliability of pumping capacity: On which supply is dependent.

9. Boiler capacity.

10. Condition and arrangement and reliability of plant equipment.

11. Fuel, and accessories for the transmission of power.

12. Pumping stations.

13. Reliability and installation of supply mains.

14. Arterial system and minor distributors and gridiron system.

15. Gate valves, as to location, inspection and condition.

16. Hydrant distribution, size, installation and condition.

It is not the purpose of this paper, nor is it feasible in so brief a time, to enter into all the details of water works engineering, but I have endeavored to show that improvements which will raise a city one full grade of protection will result in a reduction of 8 to 13% in the basis rates on frame and brick buildings respectively.

The foregoing paper was presented at the recent annual meeting of the Iowa Section of the American Water Works Association.

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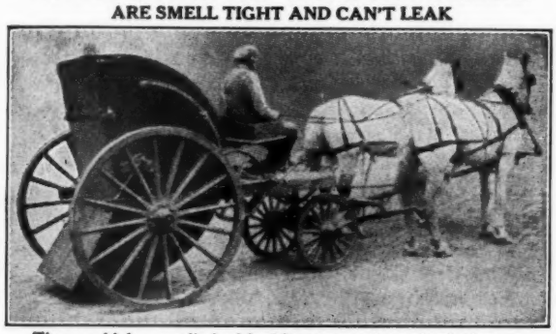

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Contracts Awarded

ROADS AND STREETS:

Ark., Arkadelphia—C. A. Reece, Fayetteville, awarded contract by Clark Co., Commrs., to construct 100 miles gravel hwy., at $415,000.

Ala., Athens—S. H. Brown & Sons, Jasper, awarded contract for completion of each end of the Bee Line Hwy. at about $53,000.

Ark., Deval Bluff—Benton Gravel & Constr. Co., Pine Bluff, Ark., awarded contr. for 12 miles of roads in Hazen-LaGrue and Slovak Road Impvt. Dist., at $191,000.

Ariz., Bisbee—F. V. McPeak, 2415 Gramercy Park, Los Angeles, awarded contract for grading and paving various streets in city at about $105,000.

Cal., Sacramento—Jos. G. Donovan, 780 Francisco, awarded contr. for paving streets in 13 blocks with 4-in. conc. base and 1½-in. Warrenite surface, at abt. $90,000.

Cal., Sacramento—Jos. G. Donovan, 780 Lyon St., Los Angeles, awarded contract for grading and paving with concrete 8.2 miles state hwy. in Fresno Co., betw. Coalinga and Oil King school, at $128,886.

Cal., Exeter—Federal Constr. Co., San Francisco, awarded contr. for paving streets in 13 blocks with 4-in. conc. base and 1½-in. Warrenite surface, at abt. $90,000.

Cal., Sacramento—J. E. Lee, Tulare, awarded contract for grading and paving with concrete 14.8 miles of state hwy., Merced county, betw. Merced and easterly boundary, at $142,750.

Cal., San Diego—Fairchild-Gilmore-Wilton Co., Pacific Electric Bldg., Los Angeles, award. contr. for paving Garnet st., Brand Ave., and Balboa Sts., Pacific Beach, San Diego, at $61,493. Paving will have 4-in. conc. base and 1½-in. Warrenite surface.

Cal., Santa Ana—Steele Finley, Santa Ana, awarded contract for paving 3.6 mi. Santa Ana canyon road, at $36,211.

Conn., Hampden (Hartford P.O.)—C. W. Blakeslee & Son, 58 Waverly St., New Haven, awarded contract for paving 15,000 sq. yds. Dixwell Avenue, concrete at about $45,000.

Conn., Hartford—L. Suzio Constr. Co., State & Brooks Sts., Meriden, awarded contract for improving 9,722 lin. ft. Lebanon-North Franklin rd., Lebanon twp., involving 6,900 ft. 7-in. native stone macadam and 2,822 ft. reconstructed macadam at about $28,000.

Conn., Waterbury—City let contract for paving 18,797 sq. yds. various streets; Warrenite asph., to Warren Bros. Co., 173 Berkeley St., Boston, at $61,754; 1,235 sq. yds. to Barbara & D'Aurio, 63 Bank St., at $7,225; block pavement, conc., 3,873 sq. yds. to Conn. Hassam Paving Co., 902 Chapel St., New Haven, at $10,805.

Fla., Lakeland—Alabama Paving Co., Birmingham, awarded contract for asphalt street paving at $185,000. This Company has contracts for asph. street paving totaling $429,592, including curbs and gutters.

Ga., Augusta—Ely Constr. Co., Augusta, awarded contract for paving the principal streets in Dublin and Washington, Ga., at $110,000 and about $83,000, respectively.

Ga., Brunswick—Atlantic Bithulithic Co., awarded contract for constr. of section A, and Georgia Engineering Co., contr. for Section B of city streets, at about $250,000.

Ga., Douglas—McDonnell Constr. Co., Jacksonville, Fla., awarded contract for paving business street of Douglas at $55,000. Paving will be of concrete.

Ga., Macon—Brooks-Callaway Constr. Co., Atlanta, Ga., awarded contract for 8.7 mi. Forsyth Rd., at $307,536; McIntire-Dowell Co., Jacksonville, Fla., awarded contract for 11,300 ft. Houston Rd., at $67,858.

Ga., Macon—McDowell Constr. Co., Jacksonville, Fla., awarded contr. for paving Houston avenue at $67,500; Brooks-Calloway Co., Atlanta, contr. for Forsyth road work at $241,000.

Idaho, Caldwell—Warren Construction Co., awarded contract for paving in City, at $193,812. Work will not start until water mains are laid by J. F. Forbes of Caldwell in about 3 weeks.

Ill., Chicago—J. A. Rose & Co., awarded contract for grading and paving with 7 ins. Portland Cem. conc., rdway of alley betw. West Lake St., Park Ave., N. Paulina and N. Hermitage streets; J. A. Ross & Co., contr. for constructing tile pipe sewer with new brk. manholes and new brk. catch-basins complete, grading and paving with 7-ins. Portland cement conc. surf. coated with asph. or coal tar and top-dressed with ¼-in. torpedo sand, rdway of alley betw. W. Washington blvd., W. Madison St,. N. Kilpatrick and N. Nicero aves. Following contractors also awarded contrs. for similar work on various streets in city: Peter J. O'Brien Co., Jno. Dillon Co., Standard Paving Co., Marquette Constr. Co., White Paving Co., Central Paving Co., American Asphalt Paving Co., Smith & Brown Co., Farr Bros. Co., R. F. Conway Co., (system of streets).

Ill., Joliet—L. T. Conway & Co., Chicago, awarded contract by State Dept. Public Wks. & Bldgs., for constr. of conc. sects. B & C in Cook Co., and Sec. D in Will Co., of Chicago-Joliet Hwy., at $151,435.

Ill., Springfield—Jas. Black Masonry & Constr. Co., Chicago, awarded contract for work in Sangamon Co., also one sec. in Macoupin Co., at $68,000; W. F. Smith & Co., Rensselaer, Ind., awarded contr. for work in Macoupin Co., at $307,986; Hart & Page, Rockford, awarded contract for constr. of two sects. of hard roads in Marshall Co., at $118,300.

Ind., Indianapolis—Marion Co. Constr. Co., awarded contracts for 2 road impvts. in Marion County: English Ave., at $87,500 and Sherman Drive in Irvington, at $10,000.

Ind., Indianapolis—Marion Co. Constr. Co., awarded contracts for 2 road impvts. in Marion County: English Ave., at $87,000 and Sherman Drive in Irvington, at $10,000.

Ind., Portland—Schwier & Davis, City, awarded contr. for paving, draining and grading, including curbs and gutters, on road in Penn Twp., at $38,782.

Ind., Rensselaer—Johnson & Hindsley, Medaryville, awarded contr. for stone road, Union Twp., at $20,621; Ben D. McColly, contr. for road in Newton Twp., at $10,770.

Ind., Shelbyville—Harshman & Jarrell, contr. for Davis Rd., at $4,680; D. H. Fatout, Scudder Rd., at $3,485; Ogden, Ballard & Co., contr. for Moberly Rd. at $14,316 and Avery, Weinstraut & Beagle, Waldron, contr. for Wasson Rd., at $16,950.

Ind., South Bend—White Construction Co., awarded contract for paving Lincoln Way with sheet asph., at $53,138.

Ia., Creston—Great Western Paving Co., Chicago, awarded contract for 20,043 yds. sheet asph. paving on 4-in. conc. base at $3.37; also 16,510 ft. comb. curb and gutter 42 in. wide over all at ..1.60; Lekliter-Davis Construction Co., Corning, Ia., contr. for 9,387 yds. 3-in. brk. paving, asph. filler on 6 in. conc. base at $4.09; also 5,000 ft. comb. curb and gutter, 30 ins. wide over all, heavy type, at $1.60.

Ia., Elliott—Mid-West Paving Co., Des Moines, awarded contract for 26,433 yds. asph. conc. paving on 4 in. conc. base at $3.17; 2,050 ft. comb. curb 42 in. wide over-all at $1.47 and 17,489 ft. comb. curb and gutter 42 in. wide over-all at $1.45.

Ia., Sidney—Agin & Fuller Corning, Corning awarded contract for 38,000 sq. yds. vert. fiber brk. pavement and 6,700 ft. 10-24 in. storm sewers, at $191,146.

Ia., Tabor—Leckliter-Davis Constr. Co., Corning, Ia., contr. for 21,688 yds. 3 in. brk. paving asph. fillers on 4 in. conc. base at $3.91; also 7,788 ft. comb. curb and gutter 42 in. wide over-all at $1.67.

Ia., Villisca—Akin & Flutter, Corning, Ia., contr. for 6,300 yds. 3 in. brk. paving, sand filler on 4 in. conc. base at $3.60; 26,000 yds. asph. conc. pavement on 4 in. conc. base at $3.15; 20,611 ft. comb. curb and gutter 42 in. wide over-all at $1.47 and 3,452 ft. 6x18 in. curb at $0.75.

Ia., Waverly—Bryant Paving Co., Waterloo, awarded contract for paving Bremmer Ave., N. Union St. & S. Beech St., at about $87,000.

Kans., Burlington—J. K. Shinn, Independence, Kans., award. contr. for 4 miles of paving at about $220,000. Business sts. are to be paved with brick and remainder with asph.-conc.

Kans., Ellsworth—M. A. Ammerman, Salina, awarded contract for paving Douglas Ave., at $59,510. Contract calls for 3-in.

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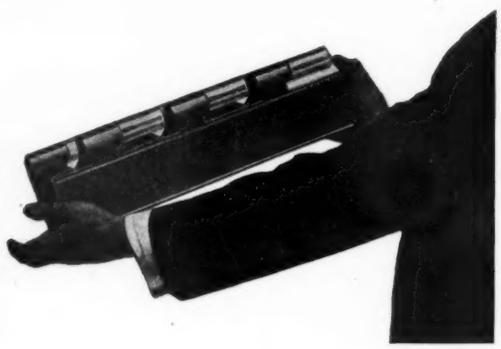

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fibre brick, 5-in. concrete base, 1½-in. sand cushion ad asph. filler.

La., Hammond—T. G. Womack, Kentwood, La., awarded contract for 12½ mi. of road—Fluker to Independence—at $85,000.

N. J., New Brunswick—T. H. Riddle, City, awarded contract for paving Main St. in Borough of Milltown by Bd. of Freeholders here, subject to approval of Milltown Boro Council at $63,955.

Mass., Boston—Downey & Toomey, Dudley, awarded contract for bldg. 4,800 ft. road in Dudley Typ., involving 4,700 gal. bitum. materials, 6,400 cu. yds. earth and 160 cu. yds. rock excav., at $18,737; 10,000 ft. Quincy Twp., 46,500 gals. bitum. materials, 1,360 cu. yds. earth excav., etc., to E. C. Sargent & Co., Quincy, at $31,408.

Mass., Boston—Warren Bros. Co., awarded contract for laying bithulithic pavement in Cambridge St., Brighton—Brighton Ave to Henshow St., at $62,583.

Mass., Boston—B. E. Grant Co., awarded contract for laying recut gramite blk. pavement in Tremont St., Roxbury—Hammond St. to Wm. Pychon Sq., at $77,748; Jno. McCourt Co., contr. for laying recut granite blk. pavement in Summer St.,—Fort Point channel to bridge over N. Y., N. H. & Hartford R. R., at $28,195; Central Constr. Co., contr. for recut granite blk. pavement in Cambridge St.—N. Russell St. to Charles St., at $14,328.

Mass., No. Adams—D. S. McGrath Co., Inc., awarded contr. for resurfacing of new hwys. at Valley par and on Beaver St., at approx. $30,000.

Me., Portland—Worcester Engineering Co., Inc., Worcester, Mass., awarded contract for constructing 5,375 sq. yds. split, redressed granite block paving in Congress St., at $3.33 per sq. yd.

Md., Baltimore—P. Flanigan & Sons, awarded contract for repairng several streets, at $42,515.

Md., Baltimore—Arundel Construction Co., 911 Eastern Ave., 340 sq. yd. granite blk. & 1,540 sq. yds. vitr. brk. blks. with cement filler (Contr. No. 164) at $7,547; also Brevard St. and 2 alleys, 2,910 sq. yds. cem. conc. (Contr. 165) at $7,058; Patrick Reddington & Sons, E Lexington St., 11,920 sq. yds. cement concerete, at $33,365.

Mich., Grand Rapids—Stoddard Constr. Co., Grand Rapids, awarded contract for constr. of Assessment Distr. Rd. No. 23, at $117,035.

Mich., Mt. Clemens—Wm. Hartway, awarded contr. by Co. Rd. Comm., to construct the Armada, Richmond Hwy.,—7 mi. long, at $86,000; Alfred Campbell, contr. for 3½ miles, at $39,000.

Mich., So. Haven—Marsman & Green, Grand Rapids, awarded contract for concrete paving here at about $30,000.

Minn., Albert Lea—Fielding & Shepley, St. Paul, awarded contract for 30 blks. of paving, at $120,000.

Minn., Duluth—D. H. Clough & Co., 914½ E. 4th St., awarded general contract for paving 8th and 9th streets—14th Ave. E. to Woodland Ave., at $18,337; also contr. for paving First St., 6th Ave. to 23rd Ave. E., at $105,952; A. Bodin & Son, 3531 E. 4th St., awarded contract for paving Cook St., 40th Ave. E. to Superior St., at $59,996; A. M. Nelson awarded contract for paving 59th Ave., W.—Main St. to Elinor St., at $58,810.

Minn., Faribault—Warren Brothers Co., awarded contract by County Commissioners, Dakota County, for paving 6 miles of Jefferson Hwy. so. of St. Paul, with National Lake asphalt, at $238,374.

Minn., Glenwood—Foley Bros., St. Paul, awarded contract for 10 miles of concrete road betw. Morris and Hancock, at $280,282.

Minn., Virginia—Chas. A. Johnson, Virginia, awarded contract for paving alleys with concrete, at $22,236.

Miss., Indianola—Dunn Constr. Co., Birmingham, Ala., awarded contract for asphaltic concrete paving, at $150,000.

Mo., Kansas City—Archie Turner, award. contr. for constr. of 2¾ mi. conc. road on the Fort-to-Fort Hwy. east and west of Maywood, at $68,601.

Mo., King City—Reinert Bros. Constr. Co., 1208 N. 5th St., St. Joseph, awarded contract for 12,000 sq. yds. conc. paving on 6-in. conc. base, conc. curbing and guttering, at about $40,000.

Mont., Helena—Schluster Bros., Cartersville, awarded contr. for 4 mi. Custer Co., Tongue River Road No. 1, at $20,014; O'Neill & McIsaacs, Fort Benton, Mont., contr. for 6.13 miles in Fergus Co., Grass-Range-Rondu Road No. 00, at $18,880.

Neb., Benkelman—A. L. Cook, Ottawa, Kans., awarded contract for grading, and clay surfacing on 12.7 miles Max-Doane Rd., at 40c per cu. yd. for excavating and 90c for overhaul; also Smith & Chambers for culvert work, at $10,464.

Neb., Superior—Mr. Watt, award. contr. for 37 blocks of asph. conc. paving and 3 alleys with cement conc., at $2.56 per sq. yd. and curb and gutter at 95c per lin. ft.; E. M. Thompson, City, award. contr. for alley, paving, at $2.10 per sq. yd.

Neb., Wahoo—Allied Construction Co., Omaha, awarded contract for paving 40 blocks in Wahoo, at $264,015. The paving is to be of brick.

N. J., Elizabeth—Weldon Contracting Co., awarded contr. for paving Springfield Ave., New Providence, at $40,131; Chas. Arny, awarded contract for brdg. at Monroe Ave., Rahway, at $26,349; C. H. Winans, award. contract for paving intersections of streets on county road in Union Twp., at $1,485.

N. J., Elizabeth—Street paving awards let as follows, involving aggregate expendt. of $121,926.69: Magnolia Ave., to Uvalde Asphalt Co., at $31,750; Alton St., to Standard Bithulithic Co., at $6,969; Chilton St. to Uvalde Asphalt Co., at $13,172; Grove St., Standard Bithulithic Co., at $19,133; Springfield Road, Standard Bithu. Co., $30,810; Monmouth Rd., $11,091; Fanny St. sewer to C. Wade, at $1,078.

N. J., Ridgefield Park—Maurice J. O'Connell, awarded contract for impvt. of Park and Poplar streets, at $60,000; Hackensack Ave. impvt. let to Hamilton & Phelan, at $20,412.

N. M., Gallup—S. P. Gillis Construction Co., Arizona, awarded contract for paving 15,000 sq. yds. paving in business district of city, at $68,000.

N. Y., Albany—M. F. Dollard, awarded contract for improving Banker and other streets, at $114,519.

N. Y., Brooklyn—Following contracts for regulating, grading, curbing and laying walks on E. 38th St., let by E. Riegelmann, Boro. Pres.: J. Massio, $4,315, on E. 38th St.; Grimm Constr. Co., 460 Herold Ave., Richmond Hill, 51st St., $4,435; 47th & 51st Sts., to Uvalde Asphalt Paving Co., 1 Bway., N. Y. City, $42,526 and $10,681, respectively.

N. Y., Ithaca—Warren Bros., 124 Berkeley St., Boston, awarded contract by Council for paving Neaga Ave., Dryden Rd. and portions of East Seneca and Cascadilla Sts. (bithu.), at $34,489; P. D. Conley, Ithaca, contract for Stewart Ave., Prospect, Clinton and Westport Sts., at $67,446.

N. Y., New York—F. L. Dowling, Pres. Manhattan Boro., let following contracts for regulating and repaving with granite block on conc. fd. certain streets; Roadway of James Slip and Leroy St, to W. J. Fitzgerald, 547 W. 45th St., at $18,977 and $25,300, respectively; sheet asph., Wall St. to Sicilian Asphalt Paving Co., 41 Park Row, at $21,564; 79th St. to J. L. Brusstar, Harlem River and 150th St., at $43,922; Broadway to Asphalt Constr. Co., 2197 Madison Ave., at $47,669.

N. Y., New York—F. L. Dowling, Pres. Manhattan Boro, let the following contracts for regulating and repaving with granite block on conc. fdn. certain streets: Roadway of James Slip and Leroy Sts., to W. JJ. Fitzgerald, 547 W. 45th St., at $18,977 and $25,300, respectively; sheet asph., Wall St. to Sicilian Asphalt Paving Co., 41 Park Row, at $21,564; 79th St. to J. L. Brusstar, Harlem River and 150th St., at $43,922; Broadway, to Asphalt Constr. Co., 2197 Madison Ave., at $47,669.

Ohio, Akron—J. C. McCormick, awarded contract for constr. of Springfield Road, at $93,000. Road will be abt. 2½ mi. long and will be built of rein.-conc.

Ohio, Akron—A. W. Hinaman, awarded contract for grading and laying walls on Grace St., Lawton St. and Diagonal Road, at $31,860; also for laying and relaying walks on 26 streets, at $26,795..

Ohio, Alliance—Leo McCormick, Ravenna, award. contr, for constr. of improved rd. from Mogadore to N. Springfield—2.3 miles, at about $40,000 a mile.

Ohio, Cleveland—Enterprise Paving Co., awarded contract to pave half mile of Harvard Ave.—Jennings Rd. to e. end of Harvard Denison viaduct with brick, at $33,193.

Ohio, Columbus—Harness-Renick Co., Williamsport, awarded contract for improving 11 miles of Alkire Road—county line thru Georgesville and Galloway to Harrisburg Pike, at $165,611.

Ohio, Columbus—Robert J. Dienst, Columbus, award. contr. for paving Kelso Rd.—High St. to Indianola Ave.—at $45,176 (brk. pavg.); A. G. Pugh, Columbus, award. contr. for resufacing Atcheson St.,—20th to Graham—with asphalt, at $34,037.

Ohio, Fremont—Modern Construction Co., Fremont, awarded contract for brick work on Upper Sandusky-Tiffin Rd., Seneca Co., at $103,842—rd. 4.28 miles in length.

Ohio, Fremont—W. E. Dorsey, Findlay, awarded contract for constr. of 6 mi. brick rdway. between Findlay and Fostoria, at $237,419.

Ohio, Piqua—Burk Bros. Constr. Co., Indianapolis, awarded contract for paving Piqua-Urbana Rd. within corp. limits of Fletcher, at $15,661; Swan Engineering Co., Dayton, awarded contract for paving Covington-Dayton Rd, at $96,509.

Ohio, Toledo—County Commrs., let following contracts for more than $300,000 worth of road bldg: M. P. Hannin, Yondota Rd. and 3 streets in Parkside Addn., at $135,826; Sylvania-Alexia Rd., by R. A. Carrigan, at $107,828; Arthur Langenderfer, Lyons Rd., at $25,390; Warner & McKecknie, Key St. Rd., at $40,579.

Okla., Okmulgee—Park-Moran Co., award. contract for paving 8th St., betw. Morton Ave. and west line of blk. 6, Highland View Addn.; 7th St., Choctaw to Miami Aves.; also Chickasaw, Miami and Osage Aves.,—6th to 8th Sts., at $102,522.

Ore., Pendleton—Dalrymple & Ackerman, awarded contract for work on Highway from Union Vo. line west to Pendleton, at $117,474. Road is to be macadamized and graveled; 27 miles in length.

Pa., Beaver Falls—Albert R. Dahl, Ellwood City, awarded contract for bldg. Ellwood-Wampum Rd., at $216,075.

Pa., Harrisburg—Following awards made by Hwy. Commr. Sadler: Warren Moore & Co., Philadelphia, 28,821 ft. Richmond and Covington Twps., Tioga Co., at $267,467; Harrison & Co., Inc., Derry, 37,885 ft. betw. Garrett and Berlin, Somerset Co., at $410,240; Mainwaring & Cummins, Inc., Philadelphia, 14,883 ft. betw. Pipersville and Plumsteadville, Bucks Co., at $111,875; The Foundation Co., New York, 2,903 ft. near Lock Haven, Clinton Co., at $28,842; Mason & Hanger Co., Ins., Chambersburg, 30,197 ft. from Point Marion to State Line, Fayette Co., at $304,482; Union Paving Co., Philadelphia, 24,900 ft. on Baltimore pike to Chester City line, at $175,749.

S. C., Abbeville—Southern Paving Constr. Co., Chattanooga, awarded contract for 51,000 yds. paving, at $176,000.

Tenn., Knoxville—Murray Constr. Co., awarded contr. for 27 blocks of paving at $144,949.

Va., Yorktown—McLean Contracting Co., 1415 Fidelity Bldg., Baltimore, awarded contract for conc. road at Naval Mine Depot, at $179,560.

Wash., Mt. Vernon—Pacific Hwy.—Mt. Vernon to the Snohomish county line—awarded to the McAdam Co., at $244,664.

Wash., Olympia—McAdam & Co., Seattle, awarded contract by State Hwy. Commr., for paving 8 miles of Pacific Hwy., betw. Mt. Vernon and the Snohomish Co. line, at $244,664; Aberdeen Paving Co., Aberdeen, award. contract for paving 3 miles of Olympia Hwy., west of Montesano, at $80,333.

Wash., Vancouver—United States Contractnig Co., awarded contract for impvt. of Pioneer-Ridgefield road (abt. 4½ miles) at $92,090.

Wash., Seattle—Kaiser Paving Co., awarded contract for paving of Thorndyke ave. and other streets on Magnolia Bluff; together with sewers and walks, at $150,000.

W. Va., Martinsburg—Harrison & Co., Inc., city, awarded contract to build sect. from Berling to Garrett, Pa., at $410,000.

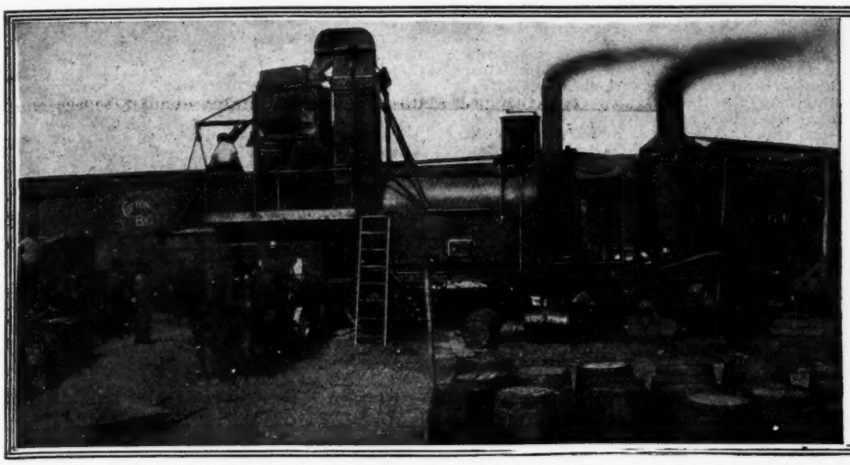
Wis., Kenosha—Christ Peterson, award. contr. for paving Garden street with repressed brick, N. Chicago street., N. Fremont ave., Lyman ave., and Cameron Court with vert. fibre brk; Western Impvt. Co., Racine, awarded contracts for asph. pavements on Elizabeth street, Bain ave., Maple ave., Orange and Broad streets. Total cost of contracts, $235,000.

Wis., Sheboygan—J. Braun Constr. Co., Penn. ave., awarded contract by city for grading and paving 1.9 miles E. Water st.—Center ave. to 5th St., and N. 6th St. to Penn. ave., 20 ft. wide, at abt. $20,000. Pestien & Nauman, N. 15th St., city, award. contr. for grading and paving 2.2 miles N. 10th st.—Superior to Geele aves., at $29,790.

Wyo., Casper—Warren Constr. Co., Billings & Portland, Ore., awarded contract for laying 105,000 yds. paving on main business streets and residential section, at $357,000.

SEWERAGE AND SEWAGE TREATMENT

Cal., Los Angeles—Adam Dalmatin, awarded contract for constructing a cement pipe sewer in Fries ave., betw. J and L streets, Wilmington, at $6,290; B. De-



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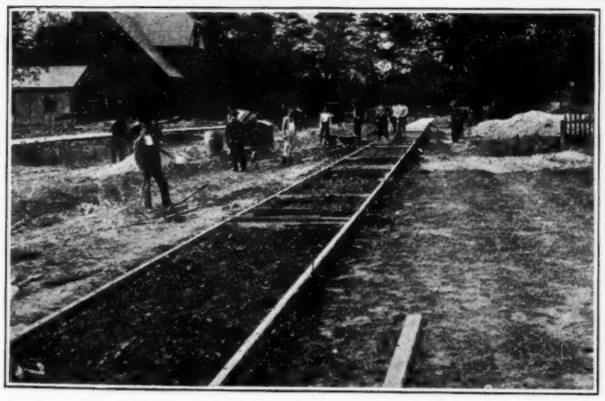

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Springfield Paving Brick Co.
SPRINGFIELD, ILLINOIS

ragno, awarded contr. for cement pipe sewer in F street, at $838.75.

Cal., Los Angeles—Mike Chutuk, award. contr. for constructing cement pipe sewer in 63d Pl., betw. Vermont and Denver aves., and other sts., in 63d Pl. sewer district, at $79,229; Adam Dalmatin, award. contr. for constructing cem. pipe sewer in Phillips Way, betw. Range View ave. and Coringa Drive and other streets in Phillips Way sewer district, at $7,444.

Cal., Los Angeles—B. Deragno, award. contr. for constructing cement pipe sewer in Meridian street at $1,415; Adam Dalmatin, contr. to construct cement pipe sewer in 71st street, at $1,487.

Cal., Riverside—R. T. Shea & Co., Riverside, award. contract for constructing vitr. pipe sanitary sewer in Miller and Van Buren streets, at $2,599.

Colo., Merino—Arman Constr. Co., Pueblo, awarded contr. for constr. of sanitary sewer here and water supply system at $48,198, for sewer and $48,000 for water works.

Conn., Hartford—N. C. Nasciano & Co., 208 Front St., awarded contr. by city for bldg. 500 ft. 48-in. conc. or block sewers in Nook Farm, at $11,623.

D. C., Washington—Thos. Hampton, 710 14th st., N. W., award. contr. by Dist. Commrs. Washington Suburban Sanitary Dist., to construct sewer and water systems in Hyattsville (Md.) Water and sewer Dist.; 7,200 lin. ft., 6, 8 and 10-in. vitr. pipe sewers.

Ga., Cartersville—J. B. McCrary Co., Atlanta, awarded contract for sew system.

Ga., Gainesville—J. B. McCrary Co., Atlanta, awarded contract to construct main line sewer from Church st. in city to the Chattahoochee river, at cost of $27,000.

Ind., Indianapolis—Columbia Constr. Co., awarded contract for construction of sewer at Tremont ave.—10th street to 363.3 ft. north of 14th st., at $4.75 a lin. ft., total $10,948.76; Sheehan Constr. Co. award. contract for sewer in Dearborn and Olney streets—30th st. to a point 176.5 north of 25th st., at $27,824.

Ind., New Albany—M. L. Underhill, awarded contract for Glenwood Place sewer on Spring street, 1,900 ft. long, at $5,250.

Ind., South Bend—Hoban & Roach, So. Bend, awarded contract for Madison St. trunk sewer, at $31,232.

Ind., South Bend—Jos. Luther, awarded contract for water connections on certain streets; Bruno De Paepe, contract for sewers on Kosciusko, Grand, Warren, and Carlisle streets.

Ia., Aurelia—J. M. Lewis, Sioux City, awarded contract for laying sewer lines at about $24,793—8-in. vitr. pipe at 85c; 10-in. $1.60; 12-in., $2; manholes, $80 each; Hawkeye Construction Co., Webster City, Iowa, awarded contrct for erection of sewage disposal plant, at $10,800.

Ia., Brighton — Empire Constr. Co., awarded contract for constr. of sewage disposal plant here at $15,000, and sewers at $35,000.

Ia., Centerville—E. L. Royer, Des Moines, awarded contract for sanitary sewer, at $35,000.

Ia., Keokuk—McManus Quarries Co., awarded contr. for sewers in West Keokuk, at $6,865.

Ia., Ottumwa—J. D. Turner Improvement Co., Des Moines, awarded contract by Council of Albia, Ia., for constr. of an extensive addn. to sewage system of city, at $49,411.

Ia., Ottumwa—Jno. W. Scott, awarded contract by council for sewer work in city —several blks. of storm and sanitary sewers. On 18-in. sewer contract price is $2.37½ and on junctions and curves, $6.32 and $7.55.

Ia., Rockwell City—Carl Schlater award. contracts for complete overhauling of the Rockwell City sewage plant at $11,800.

Ia., Tama—Geo. H. Anderson, Tama, awarded general contract for repair of sewer.

Kans., Eldorado—Chanute Constr. Co., Chanute, Kans., awarded contr. for const. of sewer systems in Districts 36 and one other, at $77,395.

Kans., Marysville—W. D. Boyle Const. Co., Ry. Exch. Bldg., Kansas City, Mo., awarded contract for laying 60,000 lin. ft. 12-60 in. storm sewers, 12 manholes and 21 catch basins, at $55,000.

Mass., Boston—V. Grande, awarded a contract for sewerage works in S. Huntington avenue, betw. Bynner and Evergreen sts., at $2,426; D. Vitiello, awarded contract for sewerage wks. in Westover st., and private land betw. Addington rd. and Weld sts., West Roxbury, at $8,108.

Mass., Boston—Henry J. Pierce awarded contract for cleaning sewers in Commercial street, betw. Foster and North sts., at $1,137.

Mass., Boston—Geo. J. Regan, awarded contract for sewerage works in Ridge Rd., Dorchester and Hyde Park, at $4,279.

Mich., Birmingham—Gilles & Hosmer, Pontiac, awarded contract for laying 600 ft. 8-in. and 238 ft. 6-in. sewer in Brown st., at $1,198; 2,130 ft. 8-in., 406 ft. 6-in. sewer, 40 ft. 8-in. c. i. pipe in Maple ave., $3,396; C. Mike, Pontiac, contr. for 800 ft. 8-in. and 369 ft. 6-in. sewer in Purdy st., $2,177; C. Johnson, Pontiac, 1,985 ft. 8-in. and 982 ft. 6-in. sewer in Southfield ave., at $4,539; T. Evanoff, Pontiac, 1,470 ft. 8-in. and 644 ft. 6-in. sewer in Pierce st., at $3,569.

Mich., Dearborn—Pitt Constr. Co., award. contract by C. W. Hubbell, for sewage disposal plant.

Mich., Dearborn—Geo. R. Cooke, 1260 Penobscot bldg., Detroit, Mich., awarded contract for constructing sewers at $71,-120.

Mich., Detroit—Dept. Public Wks. let following contracts: Bldg. 10,513 ft. 13-18 ft. conc. arch sewer in Wetherby Ave., Sections 1 and 2, to Nash Bros., 10 S. La Salle St., Chicago, at $990,479; 1,251 ft. 5-ft. cylinder brk. sewer in Harper Ave., Sects. A and B, to C. H. Bennett, 1008 Ford Bldg., at $54,042; 8,604 ft. 9-10 ft. cylinder conc. sewer in Lynch Rd., Sects. 3 and 4, to J. Connelly Constr. Co. Dime Bk. Bldg., at $438,000; 6,000 ft. 10 ft. 6-in. cylinder conc. blk. sewer in Six Mile Rd., Sec. 1, O'Rourke Engrg. & Constr. Co., and Hoag and Dall, Commercial Bk. Bldg., Cleveland, at $379,-500; 6,709 ft. 10 ft. 6-in. cylinder conc. segmental blk. sewer on Six Mile Rd. Sect. 2, to Brandon & Hanna, 1,624 Dime Bank Bldg., at $422,000.

Mich, Grand Rapids—Vander Weele Bros., awarded contract for constr. of sewer in Burton St., S. E.—Madison Ave. to Jefferson Ave. at $1,842.

Mich., Muskegon—E. W. Krueger awarded contract by Council for constr. of Spring Street and Wood Avenue sewer, at $159,-214.

Minn., Coleraine—A. A. Mitchell, Grand Rapids, awarded general contract for sewer system in Dudley Avenue.

Minn., Duluth—Jno. Hedberg, awarded general contract for sanitry sewer, 51st Ave., W. from Ramsey to Roosevelt St., at $5,691; C. R. McLean, contract for storm sewer in Woodland and Wallace Aves., 5th to Luther at $46,695.

Minn., Duluth—C. R. McClean & Son, Duluth, awarded contr. for bldg. sanitary sewer in Wallace Ave., 5th to Luther Sts., at about $47,000.

Minn., Mankato—F. A. Webster, St. Paul, awarded contract for sanitary sewer system for N. Mankato, at $51,000.

Minn., St. Paul—O'Niel & Preston, low bidders on Summit-Pascal sewer system, at $88,000. Est. cost of the work was $93,-357.

Minn., Sherburn—W. B. Carter, Sioux City, awarded contr. in install sewer system, at $51,736.

Mo., Kans. City—Torson Constr. Co., award. contr. for constr. of lateral sewer to care for 80 per cent of dist. bounded by Troost Ave., The Passeo, 58th Sy. and Mever Blvd., at $72,982.

Mo., Macon—W. McClurken, 3807 Westminster Ave., St. Louis, Mo., awarded contract for bldg. sewage disposal plant at about $16,000.

Neb., Fullerton—Jackson Bros., local, award. contr. for constr. of sewers in Dist. 4 and 6 at $1.10 for 8-in. pipe.

N. J., Elizabeth—Christian Wade, awarded contract for Fanny Street Sewer at $1,078.

N. J., Pleasantville—Edw. G. Britz, New York, award. contr. for 11½ mi. sewerage system—Lorraine avenue to Park avenue, also branches at intersecting streets, at $86,310.

N. Y., Albany—Jno. Doyle Plumbg. Co., awarded contract for new sewer at Spencer and Jackson streets, at $2.623 and one in Morton Ave.—Clinton to Elizabeth streets, at $2,416.

N. Y., Binghamton—Clarence Rose, contract for constr. of storm water sewer in Mill Street, at $19,581.

N. Y., Syracuse—F. S. & A. Sposato, Syracuse, awarded contract for bldg. Sect. D, west branch of 17th Ward Sewerage System, at $71,581.

N. Y., Utica—F. M. Johnson, awarded contract for bldg. sanitary sewer beginning at Eagle & St. Vincents Sts. & extending to Brookside Park Pl.; also storm sewers in Mortimer, Leah, Eagle and St. Vincent Sts. and Conkling, Taylor and Brinkerhoff, Dudley & Seymour Aves., at $15,355 and $29,568, respectively.

N. D., Grand Forks—C. C. Jackson, awarded contract for constr. of sewers in Dist. No. 10.

O., Barberton—W. J. Irwin, Greenville, awarded contract for bldg. W. End Sanitary Lateral Sewers at about $130,000.

O., Cleveland—Randell & Cooper, Cleveland, awarded contract for constructing sewer in St. Clair Ave., at $32,157.

O., Cleveland—Masters & Mullen Constr. Co., awarded contract for construction of West Side sewage disposal plant, to be erected at 63rd St. and Edgewater Park, at $67,800.

O., Hamilton—J. H. Trunck, City, award. contr. for constructing 8-in. and 5-in. sewer pipe on Garden Ave., at $3,094; W. M. Davis, City, awarded contr. for 8-in. sewer pipe and excavation for sanitary sewer at $8,188.

O., Lancaster—Wilson & Carpenter, Lancaster, awarded contract for sewer on S. Broad Street at $10,110.

O., Springfield — Following contracts awarded upon recommendation of City Manager: N. Limestone street, N. Street to 333 ft. so. of Columbia St., to M. J. Cooney, at $4,822; laying of sewer in Walderpark addn. to Jas. Doyle, at $9,779; sewer in Clay and Catherine street to Patrick Caffrey, at $7,703.

O., Toledo—J. N. Bick, 601 Nasby Bldg. awarded contract for bldg. 30,300 ft. sewer in N. Collingwood Park, involving 29,307 ft. 6-12 in. vitr. pipe, 1,100 branches, 74 manholes, 1,000 ft. 6-in. c. i. force main, 200-gal. centrif. pump and conc. sewage lift, at $58,996; T. J. Kelley, 626 Avondale St., contr. for 1,737 ft. 6-16 in. vitr. sewer pipe, etc., in Harris St., at $6,401.

O., Warren—The Gessner Co., Toledo, awarded contract for sanitary sewer on South Street, at $2,920.

O., Youngstown—Patrick Grady, awarded contract for constr. of 6 sewers in Pleasant Grove at $45,281.

Okla., Lindsay—Municipal Excavator Co., Okla. City, Okla., awarded contr. for constr. of sanitary sewer, at $52,000. Johnson & Benham, Conslt. Engrs., 8th floor, Firestone Bldg., Kansas City, Mo.

Okla., Oklahoma City—Municipal Excavating Co., 200 E. Main St., awarded contract for bldg. 4,800 ft. sewers, etc., in No. Highland Pard, at about $21,000.

Pa., Philadelphia—P. Ellis, Philadelphia, awarded contract by Bureau of Surveys, for bldg. sewer in Chew street at $10,000.

Pa., Wilkinsburg—Boro let contracts for laying sanitary and storm sewers in Penn. Ave. and Northern Pike to Critelli, Rilica & Zappa, Sharpsburg, at $2,400; Anderson street—Sadie to Boro line—to M. O. Herron, So. First and McKean streets, Pittsburgh, at $5,763; in sections of Wallace avenue, Hay and North streets to Manella Constr. Co., Pittsburgh, at $4,144.

S. D., Parkston—Ellerman & McClain, Yankston, awarded contract for construction of sanitary sewerage system, at $59,-537. This includes extension of water mains.

Utah, Ogden—Gibbons & Reed Constr. Co. Salt Lake City, awarded contract for sewers in Districts 140 and 143, at $29,960 and $15,-780.

W. Va., Weston—Chas. E. Collins, 636 Drexel Bldg., Philadelphia, Pa., awarded contract to construct sewerage treatment works for State Hospital, includes filter 70x85 ft. sedimentation tank, pumping plant, c. i. force main and effluent pipe.

Wis., Durand—W. C. Fraser, 707 Guardian Life Bldg., St. Paul, awarded contract for sewers at $64,897.

Wis., Janesville — G. W. Mulholland, awarded contract for sewers in Districts 3, 4, 5, 10, 11, 12, 14, 15 and 16, at $31,375.

Wis., Jefferson—G. W. Leisman, Fort Atkinson, Wis., awarded contr. for sanitary sewers at $3,080; 3,000 lin. ft. 8-in. pipe, 7 manholes.

Wis., West Bend—Keating Constr. Co., local, awarded contr. for sewers on 4th avenue, 5th 6th and 9th avenues, at $1.50 per lin. ft.; 2,700 lin. ft.

WATER SUPPLY AND PURIFICATION.

Cal., Oakland—East Bay Water Co., 9th St. and Bway, will build by day labor a distribution reservoir on 39th avenue, involving 13,800 cu. yds. excav., 108,441 sq. ft. mass concrete, 102,131 sq. ft. roofing, etc. Abt. $86,000.

Cal., San Francisco—Stone & Webster, Boston, awarded contract for construction of new Caribou Hydroelectric plant for Great Western Power Co. Approx. cost, $7,500,-000. Wk. will include installation of two 20,000 kilowatt units.

Cal., San Francisco—Martin & Messner,

care General Contractors' Assn., Sharon Bldg., awarded contr. by Spring Valley Water Co., for bldg. rein. conc. reservoir at Frisco and Larkin streets.

Colo., Merino—Arman Construction Co., Pueblo, awarded contract for construction of water supply system at $48,000; also sanitary sewer system at $48,198.

D. C., Washington—Thomas Hampton, 710 14th St., N. W., awarded contract by Wash. Surburban Sanitary Dist., to construct water and sewer systems in Hyattsville, Md., Eater & Sewer Dist. 6,500 lin. ft. 6 and 8-in. c. i. water mains, 16 fire hydrants, etc.

Idaho, Caldwell—J. F. Forbes, City, awarded contract for work of replacing present system of wooden mains with cast iron pipe, at $27,826.

Ind., Fort Wayne—Thrasher & Herman, awarded contract for drilling one or more wells at $3.90 per ft. for an 8-in. well.

Ia., Cherokee—Honnimen Kruse Construction Co., Spencer, awarded contract for laying 3,500 ft. additional water mains at 90 cents per ft. for 4-in. mains and 95 cents for 6-in. mains.

Ia., Holstein—Hammen-Kruse Co., Spencer, Ia., awarded general contract for excavating, calking and laying 1,200 ft. 6-in. water main; calking and laying 1,200 ft. 4-in. water main in Elmhurst Addn. and excavating to remove 1,200 ft. 4-in. water main, at $3,564.

Ia., Lytton—Des Moines Bridge & Iron Co., 1st and Tuttle streets, Des Moines, awarded general contract for water works sytsem; Thorpe Bros., contract for putting in well at $5.00 per ft.

Ia., Storm Lake—City Plumbing & Heating Co., awarded contract for extension of water main on Vestal street at $1,614.

Mass., Boston—Jos. Todesca, awarded contract for laying and relaying water pipes in Delford, Cypress, Montgomery, Linden and Spring streets; also in land of City of Boston, West Roxbury, at $1,999.

Mass., Boston—Jas. A. Barletta, awarded contract for laying and relaying water pipes in Richmond, Hanover, Blackstone and Astor streets, city proper, at $4,055; Jno. Guarino & Co., awarded contract for laying and relaying water pipes in Centre, Forbes, Greeview, Landseer, Myrtle, Walter, Warren, Wedgemere, Wright, Wachusett thoroughfares in West Roxbury and Wade St., Brighton, at $5,422.

Mich., Ferndale, (Royal Oak, P. O.)—J. A. McDace Co., 920 Fairview Ave., Detroit, awarded contract for laying water mains in Woodward avenue, in village, at $84,595.

Minn., Bemidji—Lane-Bowler Co., Memphis, Tenn., awarded general contract for overhauling water system of city, getting rid of dead ends, relaying 4-in. pipe lines to conform with 6, 8 and 10-in. mains and extending system, at $30,853.

Minn., Duluth—Simon Johnson, awarded contract for laying water and gas extensions in 104th avenue, W.; in Boulevard from 8th to 9th avenue, E.; in 9th avenue, E. from boulevard to Martha street; in Mankato street., 63rd to 64th avenue, W.; in Superior avenue, West; in Vernon street, Bryant's Addn., at $9,207.

Minn., Frazee—Pastoret Constr. Co., 510 Lyceum Bldg., Duluth, awarded contract for water works system at $29,789.

Minn., Harmony—Chicago Brk. & Iron Co., 38 S. Dearborn street, Chicago, awarded contract for bldg. 10x40 ft. compressed air water tank and pump house, at $5,301.

Minn., Moose Lake—Range Constr. Co., Virginia, Minn., awrded contract for water pumping plant and water mains; also sewers and sewerage pumping plant.

Minn., Owatonna—Herold & Buboltz, awarded contract for bldg. water main extensions on Lynn and Plainview streets at $2,459, also for sewer extension on Fremont street at $576.

Mo., Mt. Vernon—Urbauer Heating Co., St. Louis, awarded contract by Missouri State Sanitorium, for water system; 100,000 gal. steel tank on 75-ft. tower; deep-well pump; steam exhaust pump discharge and supply lines.

Mont., Polson—Nelson & Kordus, Eureka, awarded contract by city for bldg. water mains in various streets at $13,799.

Neb., Lincoln—Martz Constr. Co. awarded contract for constr. of water works on basis of cost plus 10 per cent.

N. Y., Gilboa—H. Nawn Constr. Co., 82 Savin street, Roxbury, Mass., awarded contract for bldg. dam here, same being part of Schoharie watershed development for N. Y. City water supply, at $6,819,910.

N. Y., Iroquois—Artesian Well & Supply Co., Providence, R. I., awarded contract for furnishing all materials and sinking an 8-in. well to a depth of 225 ft., at $1,800.

N. Y., New York—C. Del Blasio, awarded contract by N. J. Hayes, Commr. Water Supply, for furnishing, delivering and laying water mains and appurts. in Riverside Dr., W. 134th and 142nd streets, Manhattan Boro, in Matthews, Newton, Olin and Rhinelander avenues and Coroona Parkway, Elsmere Pl. and Unionport Rd., Bronx Boro, at $28,300.

N. Y., Poughkeepsie—Baker-Dunbar-Allen Co., Stock Exch. Bldg., Phila. Pa., awarded contract by State Hosp. Comn., Albany, for bldg. addns. and altering water supply sys. to include additional filter, changing water mains, bldg. reservoir, at Hudson River State Hosp., here, at about $52,00.

N. Y., Schenectady—E. B. Edgar, 737 Brandywine avenue, awarded contract for laying water mains in various streets, at $14,925.

O., Akron—T. E. McShaffrey Constr. Co., 173 S. Forge St., City, awarded contract by Coventry Land & Impvt. Co., for furnishing and laying 217 tons 6 and 8-in. c. i. water pipe and specials in Firestone Park.

Okla., Garber—Chicago Bridge & Iron Co., 105th street and Throop avenue, Chicago, awarded contract for bldg. water tank, 50,000-gal. capy., and 100-ft. tower, at about $7,490.

Pa., Homestead—Manello & Licento, Pittsburgh, Pa., awarded contr. for laying 2,000 ft. 4-in. water line on Larkspur, Dellia and Vine streets, at $3,567.

Pa., Tamaqua—Wertley & Houser, Pottsville, awarded contract for bldg. reservoir on Owl creek, Rahm Twp., Schuylkill Co., at about $137,000.

S. C., Paris Island—Chicago Bridge & Iron Co., 30 Church St., New York City, awarded contract by Bureau Yds. & Docks, Nevy, Dept., Washington, D. C., for erecting elevated tank and tower East Camp, U. S. Naval Training Station; Nolland-Clifford Co., 330 28th street, Newport News, Va., contract for water supply system, Marine Barracks.

Tex., Palestine — Dan LaRae, City, awarded contract for constr. of new water works dam and lake on Wolf Creek. Lake

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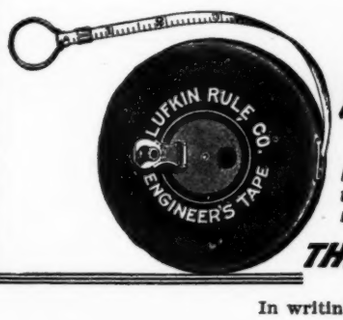

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when completed will be used as a reservoir supply of water for city and abt. 14,000 ft. of pipe will be laid to connect with water works system. Dam will be 26 ft. high and 625 ft. long and will cost $75,000. Entire new impvts. call for expenditures of abt. $125,000.

Wis., Marshfield—Farnum & Yahr, Antigo, awarded contract for excavating and back filling for 12,849 ft. 6-in. and 500 ft. 4-in. water mains; also setting 22 hydrants, at $.40 per ft.

Wyo., Lusk—Gordon Constr. Co., 334 Century Bldg., Denver, Colo., awarded contract for furnishing and installing 24,000 ft. 12-in. c. i. pipes, at $72,512.

BRIDGES AND BUILDINGS

Ala., Montgomery—H. R. Peterson, West Point, Ind., awarded contract for bldg. rein. conc. bridge over Catoma creek on Norman Bridge Rd., 25 miles south of here, at about $75,968.

Ariz., Prescott—Topeka Bridge & Iron Co., Topeka, Kans., awarded contract for constructing rein. conc. Luten Arch bridge over Verde river, 7 miles below Clarksdale, at $38,000. Bridge will be 280 ft. long.

Cal., Marysville—Yuba County Bd. of Supvrs. awarded contracts for constr. of 10 brdgs. in county; two to be in No. side of Yuga river and remaing 8 on So. side. Total constr. price $35,782. Contractors are T. H. Polk, Chico, 3 brdgs.; Jenkins & Wells, Sacramento, 1, and Edw. H. Martin, Oakland, 6.

Cal., Sacramento—Healy-Tibbits Constr. Co., San Francisco, awarded contract for constr. of state hwy. bridge, consisting of 14 steel spans of 100 ft. each and 1,230 lin. ft. rein. conc. trestle in Monterey Co., across Salinas river near King City, at $234,316.

Cal., Santa Barbara—Wm. Ledbetter & Co., Pacific Electric Bldg., Los Angeles, awarded contract for constructing rein. conc. brdg. near Guadalupe at $3,214.

Ga., Augusta—A. J. Twiggs & Son, awarded contract (subject to approval of government) for bldg. 2 conc. bridges in Richmond Co.; one across Little Spirit creek and the other across Big Spirit creek, at $21,466.

Ga., Metter—Kreis & Waldrop, Knoxville, Tenn., awarded contract for bldg. rein. conc. bridges and culverts, at about $26,000.; also contract by Commrs. of Emanuel Co., (Swainsboro) for bldg. 7 rein. conc. bridges on Dixie-Overland Hwy., at about $84,000.

Ida., Lewiston—F. W. Straw of the Security Bridge Co., awarded contract for new $7,000 bridge at Asotin.

Ill., Springfield—M. Frazier, Louisville, Ill., awarded contract for Happy Hollow and Baggot bridges, Alma Twp., Marion Co., at $3,650; P. E. Gregory, Alma, Ill., contr. for Davidson bridge, Tonti Twp., Marion Co., at $1,045; Mr. McCall, Sandoval, Ill., Glenridge bridge, Sandoval Twp., at $572; W. R. Cole, Gillispie, Ill., Roach bridge Bird and S. Palmyra Twps., Macoupin Co., at $964; W. R. Cole, contr. also for Converse bridge, Parr Twp., Macoupin Co., at $532; also contr. for Bister, Brown and Burns bridges, Chesterfield Twp., Macoupin Co., at $2,708, also Wheeler bridge, Wilyard Twp., Macoupin Co., at $1,478, also Jones No. 2, Switzer Bridges, Brighton Twp., at $1,520; M. Frazier, Louisville, Ill., awarded contr. for Hubbartt bridge, Holland Twp., Shelby Co., at $1,420; Wm. Hoos, Pittsfield, Ill., contr. for Dusenberry bridge, Griggsville Twp., Pike Co., at $1,565; Ed. M. Heaton, Marion, Ill., Reed Sta. bridge, Blairsville-Carterville, Carbondale-De Soto Twps., Williamson-Jackson Cos., at $1,492 and C. D. Stratton, Little York, Ill., contr. for McGinnis bridge, Bald Bluff, Henderson Co., at $1,525.

Ill., Springfield—L. C. Kessler, Herrick, Ill., awarded contract for Hayes bridge, Ramsey Twp., Fayette Co., at $1,490; C. S. Depew, Ramsey, Ill., contract for Cox and Hunt bridges, Carson Twp., Fayette Co., at $1,510; Wm. Long, Herrick, Ill., contract for Staff bridge, Carson Twp., Fayette Co., at $1,765.

Ill., Springfield—Thorton & Ginder, Arcola, Ill., awarded contract for Mathews bridge, Muddock Twp., Douglas Co., at $2,050; F. A. Cook, Longview, Ill., contracts for Baxter and J. T. Helm bridges, Murdock Twp., Douglas Co., at $950.

Ill., Springfield—Continental Bridge Co., Peotone, Ill., awarded contract for No. 42 and 43 bridges, Chebanse Twp., and Iroquois Co., at $2,100.

Ill., Taylorville—Miller & Husband Co., Springfield, awarded contract for bridge construction amounting to $4,900. Two bridges, conc. construction.

Ind., Attica — Winamac Constr. Co., awarded contract for repair of 6 highway bridges (repr. in each case consisting of addn. of new creo. fir.) at $5,447. Type of blks. to be used are lug-blk. Bridges are located at Independence, Kramer, two on Keys Rd., Pine Twp., and two in Jordan Twp., over Jordan creek.

Ind., Elwood—T. P. Kelly & Son, awarded contract for repairing of bridge on conc. road running east of city, at $1,850. Bridge will be widened to width of road, 18 ft. (former width 14 ft.) and strengthened.

Ind., Indianapolis—National Conc. Co., Indianapolis, awarded contract for conc. bridge over Yellew river, at $64,856.

Ind., Logansport—Co. Commrs. awarded contract as follows for bridge construction: Spencer bridge, Jefferson Twp., to Girton & Perry, at $1,553; Patterson bridge, Clinton Twp., to D. A. Hyman, at $1,873; Keesey bridge, Harrison Twp., to Chester Morgan, at $1,923; Tick creek bridge, Clay Twp., to Rochester Bridge Co., at $1,960; Fitzer bridge. Clinton Twp., to Girton & Perry, at $1,300.

Ind., Muncie—Indiana Bridge Co., Muncie, and Jno. B. Thornburg, awarded contracts for Parker Moore bridge over White river, east of here, and Lewis Bond bridge near Smithfield, at $5,648 and $1,500, respectively.

Ind., Richmond—I. E. Smith, awarded contract by Wayne County Commrs., for completion of Main Street bridge over Whitewater river at $104,600.

Ia., Davenport—T. J. McCarthy, awarded contract for 4 new conc. bridges at about $12,299.

Ia., Marshalltown — Ingersoll-Stouffer Engrg. Co., awarded general contract for steel bridge over Iowa river on E. Main street, at $31,900.

Ia., Red Oak—Following contracts for constr. of 52 bridges and culvert on standpipe road extending east from here to Adams Co. line awarded at total cost of $144,733: Wilson Constr. Co., Red Oak, 31 brdgs. and culvts. at $42,660; Koss Constr. Co., Des Moines, 5 brdgs. and culvts. at $15,782; Wickham Bridge & Pipe Co., Council Bluffs, 12 brdgs. and culvts. at $42,812; Illinois Steel Bridge Co., Jacksonville, Ill., 4 brdgs. at $43,479; Red Oak Bridge & Iron Wks., contr. for furnishing steel for all brdgs. and culvts. except 4 brdgs. to be built by Ill. Steel Brdg. Co.

Ia., Wapello—Lee R. Gabriel, Columbus City, awarded contract for construction of 130-ft. bridge across Long creek on Great White Way near Columbus City, at approx. $16,000. Contract also includes culvert.

Kans., Sterling—Koss Constr. Co., Des Moines, Ia., awarded contract for new conc. bridge across Arkansas river below Sterling, at $42,280. Bridge will be 473 ft. long, cement girders and all conc. construction.

Me., Portland—State Hwy. Comn. awarded contract for brdgs. as follows: Cry Bros., Waterville, contr. for bridgs over Piscataquis river, Howland, at $48,975; also Duck Try bridge, Lincolnville, at $18,840; Cathance bridge, Topsham, at $9,510.

Mich., St. Ignace—A. S. Decker, Flint, awarded contract for trunk line bridge No. 112, over Carp river, at $28,556.

Neb., West Point—Central Bridge and Constr. Co., Wahoo, awarded contract by village of Beemer for cement bridge and spillway within corp. limits, at $5,200.

N. J., Atlantic City—J. E. Kahle, City, award. contar. for constr. of addition to present hwy. brdg. spanning Patcong Crk. on Zion-Northfield road, at ..6,500.

N. J., Atlantic City—E. J. Holland, City, awarded contract for addn. to westerly end of Beach Thorofare brdg. on Pleasantvile t aJBv.,$,ll302d 7s.re-aCh 5::bpnK— u y Blvd., at $3,250; also contr. for widening westerly entrance to Meadow Blvd. brdg. over Beach Thorofare, at $3,250; Geo. Hanselman, Cologne, N. Y., awarded contr. for reconstr. to hwy. bridge, at $6,996.

N. J., Elizabeth—Chas. Arny, awarded contract for constr. of bridge at Monroe Ave., Rahway, at $26,349.

N. C., Dunn—J. W. Turnane, Lillington, awarded contract by Commrs. Hartnett Co., for bldg. two steel bridges here, at about $17,500.

O., Akron—Hovey & Humphrey, care E. C. Hovey, 143 Merriman Rd., awarded contract for bldg. 48 ft. rein. conc. slab and girder bridge over old Ohio Canal on Ash street, 43 ft wide, at about $13,700.

O., Dayton—Following contracts awarded by County Cmmrs.: Geo. K. Cetone, contracts for brdg. No. 56, Wayne Twp., at $862, brdg. No. 159, at $882; Chas J. Fox, contr. for bridge 205, Jefferson Twp., and J. B. K. Stansel, contr. for retaining wall for bridge 244, Miami Twp.

O., Ravenna—Ed. Pinney & Sons, award. contr. for constr. of Mud Mill creek bridge over Cuyahoga river in Mantua, at $8,853.

O., Tiffin—A. L. Leitner, awarded contract for bridge 282, Big Spring Twp. and Wilhelm bridge 190, Venice Twp., at $359 and $1,049, respectively; L. W. Dean, awarded contract for bridge 210, Clinton Twp., at $2,045.

O., Warren—Walsh Constr. Co., Cleveland, awarded contract for bldg. Niles-McDonald bridge at $139,060.

O., Youngstown—Thos. Sheehan, awarded contract by Co. Cmmrs. of Mahoning and Columbiana Cos., for conc. brdg. at $14,828, over Beaver river.

Okla., Cordell—Mann Constr. Co., Okla. City, Okla., awarded contract for constr. of 38 bridges and culverts in county.

Okla., Frederick—Midland Bridge Co., Kansas City, awarded contract for erection of bridges and culverts at $37,300.

Pa., Ambridge—E. W. Falck, Leetsdale, awarded contract for repairing and widening bridge over Big Sewickley betw. Ambridge and Fair Oaks, at $46,450.

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R. I., Providence—W. V. Polloys & Co., 1405 Turks Head Bldg., awarded contract for widening Hawkings street bridge, at about $15,000.

R. I., Washington—Randall-Stoddard Co., Chelsea, Mass., awarded contract for bldg. rein. conc. brdg. on Noose Neck Hill Rd., at about $18,450.

Tex., Canadian—A. H. Holt, City, awarded contract for concrete bridge across Red Deer creek at $16,122.

Va., Richmond—Lass Bros., Bumeville, awarded contract for Project 49, one 30 ft. rein. conc. bridge and approach over Snow creek, at $12,300.

Va., South Hill—Roanoke Iron & Steel Bridge Co., Roanoke, awarded contract for bldg. 720 ft. steel and cement bridge here, at about $47,000.

Wash., Olympia—J. M. Nichols, Tacoma, awarded contract by State Hwy. Comn. for bldg 240-ft. steel bridge at Adna, Lewis Co., on Ocean Beach Hwy., at $31,887.

Wash., Seattle—J. M. Nichols, Tacoma, awarded contract for constructing Adna bridge over Chehalis river in Lewis Co., on Ocean Beach Hwy., at $31,887. Bridge will be 220-ft. steel struct.

W. Va., Pineville—Corns-Thomas Co., Charleston, awarded contract for bldg. 2 rein. conc. bridges over Barkers creek, at $9,184.

Wis., Alma—La Crosse Bridge Co., La Crosse, awarded contract for bldg. Beef river bridge, at $12,187.

Wis., Fond du Lac—Garvey-Weinberg Co., Appleton, awarded contract for constr. of new bridge on Fond du Lac-Oshkosh Hwy., just no. of Van Dyne, at $3,865.

PROSPECTIVE WORK

ROADS AND STREETS.

Ariz., Phoenix—The $4,000,000 road bonds. Maricopa Co., voted to construct 278 miles paved highway, have been sold. Hwy Comn. now fully organized and surveys under way.

Cal., Alturas—Modoc county will expend $400,000 for impvt. of county highways.

Cal., El Centro—$1,500,000 good roads bond issue has been favorably voted on by Imperial county.

Cal., Los Angeles—Petition filed with Council by property owners asking that Hoover street—Slauson to Manchester avenues—be paved. It is proposed to pave the street with a 5-in. conc. base and a heavy warrenite wearing surface.

Cal., Pasadena—City will improve 1¼ miles of road, from Ventura street to water intake in Arroyo Seco. Petitions being circulated for impvt. of Oak Knoll avenue—First street to California street. Extensive street impvts. being considered in San Rafael Heights and in Pasedena Heights. W. H. Reeves, Cmmr. of Public Wks.

Cal., Sacramento—$40,000,000 bonds voted in state for hwy. constr., work will begin immediately. Surveys made and prelim. wk. will begin at once. Of the forty million voted, $10,000,000 will be expended in 7 southern counties: Los Angeles, Ventura, Orange, San Bernardino, Riverside, Imperial and San Diego. N. D. Darlington, Hwy. Cmmr.

Cal., Santa Rosa—Sonoma County will expend $3,000,000 for rd. impvt.

Cal., So. Pasadena—Council has adopted resolution to pave Diamond avenue, Pine street to Missouri street, with 3-in. oil macadam. Council also considering ways to secure paving of Orange Grove avenue.

Cal., Woodland—Yolo County will expend $1,700,000 on constr. of a system of permanent roads of 100 miles. Of this amount, it is proposed to raise $1,000,000 by sale of bonds.

Conn., Hebron—At special town meeting vote was cast in favor of accepting state aid and applying for $20,000 to construct state road.

Ct., Wilton—Town has voted appropriation of $20,000 for impvt. of Wilton-Westport road.

Ga., Camilla—$500,000 bond issue for good roads carried at recent election.

Ga., Quitman—Brooks County Cmmrs. will construct 80 miles permanent roads. Expend $1,000,000, including $500,000 bond issue. Garrett and Slack, Engrs., Montgomery, Ala.

Idaho—Cmmrs. Idaho Co. considering improving and completing North and South Hwy., and other county roads. $90,000 bonds sold; Latah County, Lakeside Dist., voted $75,000 bonds to grade and gravel Lakeside Hwy. D. P. Olson, care State Hwy. Dept., Boise, ngr.; $125,000 bonds voted by Troy Dist.; $175,000 by Bovill Dist. and $120,000 by Deary Dist. to improve roads in Latah County. D. Olson, Boise, Engr.; City of Sandpoint plans to pave various streets, involving 285,000 sq. ft. concrete, about $60,000.

Idaho, Nampa—$500,000 voted by Nampa Rd. Dist. for bldg. 130 mi. main roads, cross roads and cement culverts. L. Cook, Dist. Engr.

Idaho, Troy—City has voted $125,000 bonds for purpose of bldg. and improving roads here.

Ill., Belleville—Representatives of Bd. of Trade, Scott Field and War Dept. have reached an agreement regarding early impvt. of road leading from Shiloh to aviation post.

Ill., Bloomington—City Engr. E. H. Packard, instructed by Bd. Local Improvements, to prepare plans and estimates for impvt. of East Lincoln street—Main street to city limits.

Ill., Decatur—Tuscola Council considering more paving of streets here. Petition presented for paving of Daggy street betw. intersect. of that street with Main on West and Niles avenue on east; also for paving of Court street from intersect. with East Scott to intersect. with Daggy.

Ill., E. St. Louis—Plans laid for immediate paving of Shiloh-Scott Field road. Length of road 2½ miles; conc. paving. Approx. cost $60,000.

Ill., Moline—Rock Island Co. Bd. of Supvrs. appropriated $1,000 for impvt. of half-mile approach to Colona bridge across Rock river. Resolution also adopted providing for expenditure of $2,000 for grading hwy. near Meredosia bridge betw. Rock Island and Whiteside counties. Colona appropriation must be supplemented by $1,000 from Hampton Twp. and Canoe creek appropriation will be supplemented by $3,000 already raised by Twp. for purpose of grading road and paving it above high water mark.

Ill., Rock Island—Council contemplates

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paving 37th avenue—12th to 18th avenues; 12th avenue—37th to 38th streets. Wk. involves 5,820 sq. yds. asph. conc. and 2,460 cu. yds. excav. Abt. $23,530. W. Treichler, City Engr.

Ill., Silvis—City contemplates paving 2nd avenue—8th to 15th streets; 9th street—1st to 4th avenues; both 24 ft. wide; 10th, 11th, 12th and 13th streets, all from 1st to 2nd avenues; 14th street, 1st to 3rd; 15th—1st. to 4th avenues, all 22 ft. wide; also 5th, 6th and 7th streets. W. Treichler, Rock Island, Engr.

Ind., Greensburg—Petition filed for constr. of conc. road from the Columbus Pike 3 miles west of city to Jennings County line through Westport and connecting with Letts by a spur. Nearly two hundred signatures on petition.

Ind., Hicksville—Paved streets to be constructed here this year at end of West High street on the Antwerp pike and Fort Wayne road; also on East High street to corp. line, are estimated to cost $60,000.

Ind., Seymour—Indiana Hwy. Comn. considering impvt. of Seymour-Madison road, this summer for dist. of 2½ miles out of city.

Kans., Council Grove—Morris County is to receive Federal aid of 40 miles of roads. Leigh & Hunt, Kans. City, will make survey anl specfs.

Kans., Emporia—Petitions for 53 miles hard-surface road signed in Lyon Co., and a 20-mile surfacing project is under consideration. Roads assured are the New Santa Fe Trail from west to east end of county and the road connecting Empira, Admire and Reading.

Kans., Hutchinson—Section of county road from Pretty Prarie to Kingman County line (3 mi.) will be put on established grade; 2 conc. culvts. will be constructed and conc. overflow, 150 ft. in extent will be built. Plans drawn by Co. Engr. and approved by Co. Commrs.

Kans., Syracuse—$50,000 road bonds voted by Hamilton County.

Kans., Wichita—Comn. has granted petitions for paving Fern street—Douglas avenue to Hancock avenue; Third street—Vassar to Roosevelt avenues; 21 separate projects now waiting advertisement for bids on construction. This includes petition on part of property owners for 47 blks. of either paving or constr. of curbs and gutters.

Ia., Council Bluffs—Douglas County, Nebraska has voted in favor of $3,000,000 bond issue to pay for 115 miles of paved roads. Proposition received 1,000 more votes than was necessary to carry it.

Ia., Davenport—Council has issued official notice of intention to pave following streets and alleys: section of Fairfield street, asph. conc., brk. or bithulithic. Est. cost, including intersections, $18,665; Park Lane, $16,-699; Eola street, $4,302; Myrtle street, $4,-540; alley betw. Charlotte avenue and Sixth street, $3,898. Hugo Moeller, City Clk.

Ia., Davenport—Eight miles of primary highway will be paved in Scott Co. Approx. cost, $120,500.

Ia., Des Moines—Plans in progress for grading 14th street—Grand to Locust. Est. $75,000. Resolutions also passed for curbing Stewart street—Walker to Garfield; Rollins avenue to end of same; Rollins avenue, 28th to end of same and Stewart avenue—Walker to Garfield. Frank Jefferies, Clk.

Ia., Palo Alto—Bd. of Supvrs. have taken steps to begin paving county primary road system, in accord. with recent election. Rd. betw. Emmetsburg and Mallard will be first to be paved. County will also have funds available for graveling 24 miles of secondary system.

Ia., Sac City—Resolution adopted by Council for paving sections of 9 streets and several alleys. Resolution provides for receiving of bids upon eight different kinds of paving, namely: asph., conc., brk., blk., Portland cement, conc. of several different specfs. and bithulithic.

Ia., Sioux City—Woodbury County has voted favorably on $2,500,000 bond issue; funds to be used to pave county primary road system. It is expected, however, that the work will cost at least $3,700,000 before it is finished. Engrs. estimate that it will take 2,150 cu. yds. concrete to pave each mile of work; total number cu. yds. required for entire 125 miles would be 268,750. It is estimated that 4,629,650 bbls. of cement will be required for the project; also 1,119 cu. yds. sand to each mile of paving, or approx. 139,875 cu. yds. for whole 125 miles.

Md., Baltimore—State Roads Comn. will expend approx. $3,000,000 this year in new construction. Something like $120,000 will be spent in each of the 23 counties of the state. In Baltimore work is abt. to be undertaken which will cost abt. $200,000. More may be done later. Biggest job to be done in city this year will be on Monroe street, which will be paved from Columbia avenue to Reisterstown Rd. Contracts amounting to 1,447,713 have been let in the counties exclusive of cost of rebldg. rdwy. and constructing conc. shoulders on Elkton-Baltimore-Washington road. Roads to be constructed this summer and fall will generally be 15 of 16 ft. wide instead of 14 ft., and will be 8 ins. deep in center and 6 ins. on sides.

Mass., Boston—Public Works Dept. will expend $152,000 and Boston Elevated $104,-000 for repaving Tremont street between Dover and Northampton this summer. City will remove granite blocks and subsitute asph. on a concrete base.

Mass., Chicopee—Bd. of Aldermen passed bond order of $141,400 for paving of many streets. Work will start soon.

Mass., East Longmeadow—$55,800 appropriated for following roads Mapleshade avenue and Wilbraham road, from Four Corners, $12,000; East street, Four Corners, $6,500; Maple street, from N. Y., N. H. & Hartford R. R. tracks, $7,000; Hall Hill road, $13,500; Chestnut street, $2,100; Michaels Cor. toward Conn. state line, $7,200; Baptist Church to Hewlett, $32,100; from Patrick Connor's to present perm. paving, $700; Pleasant street from present paving, $4,200.

Mass., Great Barrington—Town Finance Comn. has made following recommendations for special town meeting: Paving Main street, St. James Place south, $15,000; for cement road from Belcher's Square, north, $16,000. Repair of Railroad street pavement, $1,000.

Mass., Salisbury Beach—$22,000 will be expended for constr. of new road at Salisbury Beach. Road will be 40 ft. wide and will extend along the water's edge.

Mich., River Rouge—Plans being prep. by J. Jerome, Engr., 1331 Majestic Bldg., Detroit, for paving with one course conc., conc. curbing, Burke avenue, Dearborn to Jefferson avenues; Henry avenue, Burke to easterly line lots 120 and 153; also sections of Maple street, Burke to Riopellis subdivison; Pine street, etc. R. J. Peters, 9 S. Dearborn Ave., Clk.

Minn., Duluth—City Commrs. authorized paving 64th street, Grand avenue to Roosevelt street, 24 ft. wide. Est. cost, $22,408. J. A. Farrell, Commr.

Minn., Duluth—Resolution adopted for paving Railroad street, 18 ft. west of the west side of 7th street, west to Garfield avenue. There will be a brick rdwy., 30 ft. wide. Est. cost, $83,113.

Minn., Duluth—City Commrs. have authorized paving of Winona street, Woodland avenue to Allandale avenue. Est cost, $7,-290. J. A. Farrell, Commr. Commrs. have decided to issue $400,000 bonds to cover paving and other impvts. F. D. Ash, Clk.

Minn., St. Paul—Council passed two Ords. for paving Iglehart avenue, at est. cost of $65,000. Asphalt concrete to be used.

Minn., St. Paul—Toqua Park Board has formally approved plan for scenic blvd. around the east lake near Graceville.

Miss., Columbus—U. S. Dept. Good Roads has approved plans and specfs. for Pickensville road, which will soon be improved with government aid.

Miss., Purvis—Lamar County Supvrs. plan road impvts.; $300,000 bond issue.

Mo., Jefferson City—State Hwy. Board has approved $1,500,000 expenditure during next 3 years on pricipal roads., diverging from St. Louis into St. Louis county, 56 miles; concrete considered.

Mo., Kansas City—Plans and specfs. for paving the Lone Jack road east from Lone Jack to Johnson county line (3½ miles) approved by County Court of Independence. State and Government will pay abt. $10,-000 a mile for impvts., which is one-half the total cost. Specfs. call for 16-ft. rdwy. to be paved with bitum. macadam, the penetration method of applying the asph. filler to be used. O. C. Sheley, Co. Hwy. Engr. instructed to call for bids.

Nev., Carson City—Commrs. Mineral County plan to construct 10 miles Walker Lake road. About $148,000.

N. J., Jersey City—Bd. of Freeholders, Hudson and Essex Counties plan to replace Lincoln Hwy., here to Newark, with wood block. About $10,000. City plans to improve West Side avenue, granite block. Cost will exceed $50,000. C. A. Van Keuren, City Engr.

N. J., Jersey City—Hudson Co. Blvd. Comn. considering impvt. of Hudson Co. Blvd., from Communipaw to N. Y. & N. J. R. R. tracks, at cost of $57,000; also betw. Paterson Plank road and Hackensack Plank road, $150,000; both bitum. surface on conc. foundation.

N. J., Jersey City—City had plans prepared for paving Baldwin avenue, Pavonia to Newark avenues, asph., $10,000; also for improving Jackson avenue, Fulton to McAdoo avenues, probably granite. C. A. Van Keuren, City Engr.

N. J., Trenton—City contemplates widening of Front street, Stockton to Willow. Probable cost, $500,000.

N. Y., Huntington—Proposition to bond town for $600,000 to $700,000 for constr. of from 30 to 35 miles of concrete roadway is benig discussed and is meeting with favor.

N. Y., Olean—City will spend $60,000 in paving streets.

N. C., Asheville—State Hwy. Comn., Raleigh, contemplates improving Asheville-Black Mountain Hwy., from Azalea to Black Mountain; 7½ mi. conc., macadam with tarvia top or bithulithic; $200,000 to $300,-000. Will probably invite bids.

N. C., Greesboro—Eight more Twps. have voted in favor of road bldg.; bonds amt. to total of $365,000.

N. C., Lumberton—Robeson Co. Commrs. will issue road bonds in following townships: Smiths, $75,000; Pembroke, $50,000; Howellsville, $75,000; Orrum, $25,000; Shannon, $10,000; Red Sprnigs, $10,000; Gaddy, $20,000.

O., Covington—Village Council plans to pave 900 ft. High street, Bridge street to Penn. R. R., 30 ft. wide, brk. or sheet asph. Abt. $15,000.

O., Dayton—City contemplates paving 800 ft. Superior avenue, Yuncker street to Deal avenue, 40 ft. wide, involving 1,500 cu. yds. grading, 3,800 sq. yds. macadam, 1,650 ft. cement curbing and guttering 4,00 sq. ft. 4½ in. cement walks. Abt. $10,500. O. E. Eichelberger, City Engr.

O., Dayton—City considering paving Carlisle avenue, St. Charles to Demphle streets, 30 ft. wide. Work involves 2,700 sq. yds. waterbound macadam, 8,000 sq. ft. cem. walk and 1,600 ft. cem. curbing, $3,527; (b) 3rd street, from west. corp. line to 1,708 ft. west, 36 ft. wide, 6,800 sq. yds. brick block, $52,017; (c) Alley east of Main street, 16 ft. wide, 500 sq. yds. granite durax or wood block, $1,942. F. O. Eichelberger, City Engr.

O., Hamilton—One of the biggest and most important projects being considered by the city and Butler county, is the extension of No. 3rd street from this city to Cokeotto.

O., Fremont—Seneca county will receive an additional $45,000 for rd. impvt. Of this, $20,000 will be used for impvt. of Columbus-Sandusky pike at Attica and $25,000 for Lima-Sandusky road at Bettsville. With these additions county will get $109,300 from state and federal funds.

O., Newark—City Engr. authorized to prepare plans and specfs. for paving and curbing of Railroad street and Eastern avenue.

O., Washington—City Council has begun legislation for resurfacing or paving nearly every square in the business section and also paving alleys back of business houses.

O., Wilmington—Resolution passed by Council to improve several more squares of streets: Main street, Walnut to Grant; Lincoln avenue, Locust to Penn. R. R.; Mulberry, Locust to Penn. R. R., and Grant, Main to Sugartree.

Ore., Ontario—City Council has passed resolution authorizing 3 miles paving; streets to be paved being the main or Oregon street and all smaller business streets branching from that; also California avenue, Oregon street to Holy Rosary Hosp. and east on road leading to Snake river bridge, to city limits.

Ore., Portland—Oregon voted at June election in favor of $2,500,000 bond issue, contingent upon fed. appropriation of equal sum, to construct the Roosevelt Hwy., running from Astoria to California line, through seven coast counties of state. Length estimated at abt. 350 mi.

Ore., Roseburg—County court has signed agreement providinb for co-operation in constr. of the Tiller-Crater Rake cutoff hwy. Est. cost, $63,000.

Okla., Lawton—Survey of Fort Sill blvd., preparatory to paving, has been started.

Okla., Madill—City contemplates paving approx. 40 blocks. Plans in progress. Johnson & Benham, Engrs., Kansas City, Mo.

Okla., Muskogee—City Commrs. have approved plans and specfs. for five different materials for resurfacing or paving downtown streets of city. Work may start in August. In all 98,442 sq. yds. or about 60 blocks will be paved under plan adopted by meeting. Ests. prep. by City Engr. White for various materials are as follows:

sheet asph. 2 ins. deep over present brk. pavement, $204,551; sheet asph. together with turnover on side of brks., $325,166; repaving with Boynton brk. and asph. filler, $280,393; resurfacing with Willite, $194,323; resurfacing with one inch bithulithic (Tarvia), $178, 966.

Okla., Stroud—City considering paving approx. 20 blks. Plans and specfs. being prep. by Johnson & Benham, Consit. Engrs., 8th floor, Firestone Bldg., Kansas City, Mo.

Pa., Ebensburg—Board of Commrs. has decided to contribute one-half toward cost of paving highway extending through East Conemaugh, share of county's expense not to exceed $10,000. Distance to be paved approx. 1,205 ft., which will be built with vitr. paving blk. on cinder base with 20 ft. rdwy. portion constructed with vut. paving blk. on conc. base and curb, and 20 ft. rdwy. on portion constructed with vitr. paving block. on cinder base.

Pa., Scranton—Plans prepared by W. A. Schunk, City Engr., for paving West Market street from Brick to Hollow avenues, asph., and stone block, 28 to 30 ft. wide. About $63,513.

R. I., Providence—City has appropriated $20,000 bonds to pave Waterman street, granite block. W. F. Slade, Commr. Public Wks.

R. I., Woonsocket—Resolution passed appropriating $119,500 for highway improvements; largest appropriation being $62,400 for improvements to River street; $35,800 appropriation for paving Hamlet avenue; $21,300 for paving and curbing Arnold street. These highways to be paved, curbed and surface water drains laid.

S. C., Columbia—State Hwy. Comn. has approved five road projects for state aid as follows: Grenwood, 20 mi. Dixie Hwy. Oconee, 35 mi. from Clemson College via Seneca and Walhalla to Russells; Darlington, 27. of rd. Darlington to Chesterfield Co. line; Chesterfield, Mt. Croghan Twp., 12 mi. rd; Marlboro for bldg. approx. 20 miles of road, Cheraw brdg. to Bennettsville and Clio to Dillon Co. line.

Tenn., Altamont—Grundy Co. Commrs. will issue $200,000 bonds to construct road from Pelham to Tracy City and from Monteagle to Warren County line. May secure $200,000 Federal aid.

Tenn., Dyersburg—$150,000 bonds authorized. Dyer Co. Commrs. cosidering 22 mi. Jefferson Davis Hwy., conc. or conc. asph., 12 ft. wide. D. L. Anderson, Co. Judge.

Tenn., Waverly—Humphreys County, W. C. Mark, Road Supvr., will constr. 130 miles graded road and repair steel bridges; expend $100,000.

Tex., Austin—Gov. of Texas has submitted to the legislature question of appropriating $20,000 for constr. of a hwy. in and through San Jacinto State Park and the provision of convict labor for the constr. of hwy.

Tex., Drenham—Washington Co., voted $1,500,000 bonds for road constr.

Tex., Glen Rose—$100,000 will be expended for impvt. of roads in approx. three-fifths of the county of Somerwell.

Tex., La Grange—$200,000 bonds voted by Precinct No. 1 for road constr.

Utah, American Fork—City having surveys made for paving 3,000 ft. Main street, 2nd N. to 3rd street; 32 ft wide. Huddlestone & Fiero, McIntyre Bldg., Salt Lake City, Engrs.

Wash., Wenatchee—Douglas County preparing to expend $750,000 on rd. impvts. during the years 1919 and 1920, with still more work in prospect.

W. Va., New Martinsville—Wetzel Co. Commrs. will grade and hard-surface 4 mi. of road; $105,000 bonds voted. G. W. Comstock, County Road Engr.

SEWERAGE AND SEWAGE TREATMENT.

Ark., Atkins—City will engage engineer to prepare plans for sewers.

Ark., Conway—City contemplates constructing reservoir and laying water mains. $50,000.

Cal., Los Angeles—City Engr. instructed by Council to prepare Ords. for sewering Temple street, to include Virgil, Westmoreland and Madison avenues, betw. Temple and Middlebury streets.

Cal., Los Angeles—City Council has adopted resolution to constr. cement pipe sewer in Denver avenue, Slauson avenue to so. terminus, also cement pipe sewer in Broadway betw. Pico and 12th streets.

Cal., Oakland—Public Health Service of Federal Government requested to make complete survey of Yosemite valley, together with estimates for installation of complete sewerage system with capy. sufficient to meet increased demands for many years. Upon arrival of engineer from surgeon general's office, gathering of data will begin.

Cal., Los Angeles—Map of assessment district for constr. of sanitary sewer in Pico street—Broadway district approved by City Council.

Fla., Okeechobee—City voted $45,000 bonds for sewer and water systems. D. E. Austin, Mayor.

Ga., Cartersville—$90,000 bonds voted by citizens for purpose of installing modern sanitary sewerage system.

Ill., Alton—Construction of Piasa Street sewer to be undertaken by city in near future. Engineering Dept. working on the plans. T. H. Landon, City Egr.

Ill., Danville—Plans in progress for putting in sanitary sewer system in about ½ sq. mile of territory, using Imhoff tank disposal. Est. cost $52,000. There is also another section, slightly smaller, under consideration, and a number of short runs from both sanitary and storm sewers. H. H. Edwards, City Engr.

Ill., Carlinville—Bd. Local Impvts. sending out notices of public hearing on storm water sewer to drain north part of Carlinville. Total est. cost $41,124. There will be over half a mile of 36-in. sewer and the sizes range on down to 10-in. pipe.

Ill., Joliet—Extension of sewer and water mains being discussed. Est. cost of sewer system, $41,878.

Ill., Kankakee—Bd. Local Impvts. adopted resolutions for constr. of River Street sewer system.

Ill., Springfield—City Engr. Wade Selley preparing new estmaite of cost for sewer in Ash street, 16th to 17th streets; also in 17th St., Ash to 40 ft. so. of Laurel.

Ia., Council Bluffs—City contemplates constructing and reconstructing sewers on: C & D avenue, 20th to 37th street; Wilson ave., Military ave. to 8th st.; 540 ft. 8-in. pipe, 216 ft. 6-in. pipe, 1 manhole. Besley ave., Broadway to eastern terminus, 1,150 lin. ft. 10-in. and 705 lin. ft. 6-in. pipe, 3 manholes. C. O. Frazer, City Clk.

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Ill., Springfield—Construction of sewer system for Fourth and Fifth wards being considered by City. City Engr. C. A. Standfield estimates cost at about $100,000.

Ind., Hammond—At joint meeting of officials of various cities of the Calumet region, held to consider sanitation and the pollution of Lake Michigan by sewage, Langdon Pearse, Chicago, estimated cost of constructing an intercepting sewage system for cities of Hammond, Whiting, Gary and E. Chicago at $2,500,000. These cities will soon be prohibited from dumping sewage into the lake.

Ia., Chariton—Plans in progress for sewage disposal plant and septic tank. B. Housholden, City Clk.; W. L. Perkins, Engr.

Ia., Creston—Council has passed resolution of intention to constr. 8-in. sanitary sewers in Districts 42 to 53, and 10-in. sanitary sewer in District 41; all sewers to be constructed of vitr. salt-glazed sewer pipe, with brk. or conc.-lined manholes, all joints to be luted with Portland cem. mortar. Carl Davenport, City Clk.; Ed. C. Keith, Mayor.

Ia., Keokuk—City considering constr. of sewers on 5th street in Blk. 75 to Blk. 71; also in alley to Blk. 72 and east line of 6th street; 8-in. pipe. Ed. S. Lofton, City Clk.

Ia., Muscatine—City will construct sewers in new Dists. 34 and 35. G. C. Parks, City Record.

Ia., Wall Lake—Mayne Enginering Co., Council Bluffs, will prepare plans for sewer and disposal plant.

Ia., Washington Heights—Council in favor of constructing big sewer system, which will begin at or near new Wash. School bldg. and extend down toward and connect with Hawkeye creek sewer. Preliminaries will be started so that work can begin after August 23.

Ia., Woodbine—Town considering construction of sewer system. C. D. Erlewine, Town Clk.

Ky., Fulton—City contemplates constr. of sewer system. Subject discussed at meeting of Fulton Commercial Club. W. R. Butt, of City Health Board, in favor.

La., Monroe—City Commrs. considering enlargement and impvt. of sewer system; also constr. of drainage system. Walter G. Kirkpatrick, Consit. Engr. and Director of Public Wks.

Md., Towson—Baltimore County Commrs. considering constr. of sewage disp. plant. Ezra B. Whitman, Consit. Engr., Baltimore.

Md., Baltimore—City will construct $10,000 temporary sewage disposal plant for 2,000 dwellings.

Mass., Fall River—Orders for extensive sewer constr. recommended by Comm. on Sewers. Orders calling for expendt. of $55,500 from general sewer appropriation and $35,000 from special loan for Tucker street sewer were recommended.

Mich., Benton Harbor—Petition presented to Council by residents residing east of the Edwards avenue viaduct requesting that sewer connections be made, also by residents of Jons, Madison, Winans, Waukonda, Forrest, LaSalle, Edgcumbe and Waucedah streets. Council took steps for constr. of 10-in. sanitary sewer on McAllister, Empire to May streets, to cost $3,157; resolution also passed to construct sewer on Bishop ave., Empire to May, $2,618.

Mich., Escanaba—State Bd. of Health has condemned new city sewer outlet into bay, as being too close to the water intake. Special election may be called to raise funds for change.

Miss., Brookhaven—Ord. passed by Council directing City Atty. to take steps towards issuance of city bonds not to exceed $100,000 for installation of model and complete system of sewerage.

Minn., Duluth—City Commrs. have authorized sanitary sewer in Princeton alley, Mygatt avenue to St. Andrew street, then to Sussex avenue to Kenilworth avenue; also storm sewers in Tacony st., 59th ave. W. Est. cost, $1,614. J. A. Farrell, Commr.

Minn., Kinney—Village plans to construct sewer system. Est. cost, $35,000.

Minn., Rochester—Ed. Fanning, city sanitary inspector, has recommended the extens. of the zone system so as to cover every place which has sewer and water mains and to make it compulsory for every property owner to connect with the sewerage system.

Mo., Fairfax—City considering impvt. of sewer and water systems; $40,000. Archer & Stevens, Engrs., 609 New England Bldg., Kans. City, Mo.

Mo., St. Joseph—$1,850,000 voted for municipal impvts. here and work will soon start for completion of the Whitehead sewer and Brown's branch sewer.

Neb., Broken Bow—Council has entered into contract with Grant, Fulton & Letton, Lincoln, for a survey of city and establishment of grades for both sewerage and street paving.

Neb., Grand Island—Citizens will vote on bond issue of $200,000 for larger sewer system.

Neb., Harvard—Engineer making prelim. plans for sewerage system.

Neb., Lincoln—City will build sewers in west part of city. Est. cost $65,000. City Engr. Yates.

Neb., Madison—City plans to lay 3,400 ft. 30-in. storm sewer in Third street. About $15,000. W. D. J. Steckelberg, City Engr.

Neb., Osceola—Will probably let contract about August 25 for constr. of disposal plant and sewers. Engrs. Grupe & Walters, 204 Peters Trust Bldg., Omaha. Plans in progress. Est. cost $61,973.

Neb., Tilden—Plans in progress for sewers. W. E. Standeven, Engr., 414 Peters Trust Bldg., Omaha.

Neb., Wilber—City considering constr. of sanitary sewes system. Main sewers and outlet, 4,956 ft. 10-in. vit. pipe, 3,714 ft. 13-in. vit. pipe, 27 manholes. Lateral sewers, 23,610 ft. 8-in. vit. pipe, 62 manholes, 9 flush tanks, 270 ft. service pipe. Total est. cost, $44,567. Grant, Fulton & Letton, Engrs., Lincoln.

N. Y., Syracuse—Ord. passed providing for 39-in. pipe sewer in West Mattson ave. Est. cost, $125,000.

N. C., Tarboro—City—H. D. Hardison, Mayor, considering 3 miles 8 to 12-in. vitr. pipe sewers, 6-in. house connections. Wm. M. Piatt, Engr.

Ohio, Akron—Resolutions passed to construct sewer, together with laterals, in Sherman st., Cole ave. to Archwood ave., and in Hickory st., Silver to angle so. of B. & O. railroad crossing.

Ohio, Chillicothe—Ords. passed to proceed with constr. of sanitary sewers, lateral and house connections on section of Water street and Western ave., Watts street and in Fourth st.; also in section of Western ave. Albert Scholl, Pres. of Council; Robt. T. Weaver, Clk.

Ohio, Hamilton—Ords. passed to construct sanitary sewers and house connections with vitr. sewer pipe, drain tile, manholes, etc., etc., on sect. of N. 9th st., Reservoir st., Booth ave., Miami st., Stout st., Linn st., Poplar st., Pine st. and Ridgelawn ave. Karl E. Krieger, Clk.

Ohio, Ironton—City contemplates sewer constr. in 10th st., Pine to a point 800 ft. beyond Maple ave., also from corner of 6th and Oak sts. to Locust alley.

Ohio, Lockland—Council has authorized expendt. of $15,000 for installing sewer system in northern part of village; also $5,000 for relaying walks, curbs and gutters. Plans to be prepared by Engr. Coates.

Ohio, Marion—Ords. passed to proceed with constr. of storm water sewer and cellar drain on Glade st., Bennett to second alley no. of Bennett; also on Patten st., Park st. to Ballentine ave. C. F. Smith, Pres. of Council.

Ohio, Massillon—Resolution adopted asking for estimate of cost of bldg. sanitary sewers in East Oak, Elm, Bluff and Independence streets, to connect with the Sippo creek main.

Ohio, Piqua—Ord. passed to constr. storm sewer in Dist. No. 1, in sects. of Spring, Franklin and Park aves. Cloyd Smith, Clk.

Ohio, Springfield—Approx. cost of laying sewers in these streets, $7,510.

Ohio, Springfield—Resolution adopted to construct sewer in Laurel, Cora and Florence streets. Approx. cost of laying sewers in these streets, $7,510.

Okla., Ada—Election to be called soon to vote on bonds. Approx. of $500,000 for system of storm sewers and water works extensions. Plans by Johnson & Benham, Consit. Engrs., 8th Flr. Firestone Bldg., Kansas City, Mo.

Okla., Guthrie—City will build water works; 17,900 ft. cast iron pipe. Black & Veatch, Engrs., Interstate Bldg., Kansas City, Mo.

Okla., Madill—Plans under way for extensions to sanitary lateral sewer system. Johnson & Benham, Consit. Engrs., Kans. City, Mo.

Okla., Oklahoma City—City Commrs. in favor of addition $10,000 to budget for purpose of installing immediately a temporary chemical purification plant.

Okla., Shawnee—$40,000 bonds voted by city for improving and extending sewer system.

Ore., No. Bend—Resolution passed by Council to lay modern sewer system to take care of district in no. part of town and this side of the city park.

Pa., Erie—Council approves of sewers projects as follows: Garrison Run flood prevention system, involving expendt. of $357,000; also construction of part of the Cold Spring Run flood control system, to relieve conditions on west side. Est. cost, $47,000. Storm sewer in 19th st., Cascade to Cranberry st.; Cranberry, 19th to 24th sts.; West Lake Rd., Cascade Creek to Weschler ave., and in Weschler from West Lake Rd. to 12th st.

Pa., Philadelphia—Plans and specfs. for constr. of 9 main sewers in different sects. have been drafted. Approx. cost, $1,000,000. Chf. Albright, Bureau of Surveys, has had plans prepared in order to be able to proceed with work immediately, in event proposed big municipal loan is authorized by Councils.

Pa., Philadelphia—Bd. of City Surveyors have approved plans for completion of sewer from Frankfort high level sewer in I street, so. of Ramona, to the Wingohocking Creek. Est. cost, $50,000.

R. I., Providence—Sewer construction work to amt. of $90,000 has been recommended by aldermanic comm. on sewers.

S. C., Charleston—City considering sewer construction. May issue $300,000 bonds. J. H. Dingle, City Engr.

S. D., Lake Preston—$55,000 voted for purpose of installing modern sewerage system.

S. D., Brookings—$48,000 bonds voted by city to construct storm sewers in various streets.

Tenn., Humboldt—City contemplates installing sewerage system.

Tenn., Knoxville—City soon to issue $100,000 sewer and bridge bonds. Island Home and possibly other sects. of So. Knoxville will get sewer extensions.

Tex., Dallas—City Engr. Geo. Fairtrace gives as a preliminary est. of cost of complete sanitary sewer system for city, $1,000,000, and $4,000,000 to $8,000,000 to complete the storm sewer system.

Tex., Dallas—City Commrs. approved constr. of Parry avenue storm sewer in preparation for paving of certain streets. Sewer will cost abt. $20,000.

Wash., Seattle—Property owners urgently petition constr. of trunk sewer on 63rd ave., S. W., and on Admiral Way, with laterals on adjacent streets. Est. cost, $16,385. Aug. 4th named as date for hearing. City Supt. of Sts. & Sewers Chas. R. Case urges immediate installation of proposed system.

WATER SUPPLY AND PURIFICATION

Ark., Atkins—City will engage engineer to prepare plans for water wks.

Ark., Conway—City contemplates constructing reservoir and laying water mains, $50,000.

Ark., Cotton Plant—Plans being prepared for installation of a complete water and sewer system here.

Ark., Marianna—City will improve water works. $400,000.

Cal., Blythe—$36,000 bonds voted for municipal water system at recent election. Olmsted & Gillelen, Hollingsworth Bldg., Los Angeles, Engrs.

Cal., Sacramento—Bonds to amount of $1,800,000 voted for a filtration plant for municipal water system.

Cal., San Diego—Resolution passed providing for rein. conc. dam to be constructed here with storage capy. of 14,000,000 gals. of water. Est. cost $881,270. H. B. Savage, Hydraulic Engr.

Fla., Okeechobee—$45,000 bonds voted for water and sewer systems. D. E. Austin, Mayor.

Fla., Pablo Beach—Town contemplates water works construction.

Ga., Alma—$15,000 bonds for water works and electric light plant voted.

Ga., New Holland—Pacolet Mfg. Co. will install $75,000 water works and sewer system.

Ga., Royston—City having plans prepared for bldg. water works and sewerage systems. Abt. $45,000. J. B. McCrary Co., 3rd National Bank Bldg., Atlanta, Engrs.

Ill., Bloomington—City Council will consider proposed Mackinaw River water supply propects, including constr. of dam, settling basins, coagulation and sterilization plants, 18-in. and 14-in. pipe line in clear water reservoir, installation of iron removal and softening plant in connection with Bloomington Well Supply, 30-in. pipe line, utilization of present pumping plant.

Ill., Rockford—Fairground park selected as site for new water plant to increase Rockford's water supply. Three wells to

give additional supply and 10 million gal. reservoir are to be added.

Ill., Joliet—City contemplates extension of water mains. Est. cost $34,487.

Ind., Riverdale—Federal Ice Co., proposes to lay over 4,000 ft. water main and a feeder from Indiana Ave. to reservoir at Village Hall.

Ia., Farragut—$25,000 voted at special election for constr. of municipal water works system.

Ia., Keokuk—Keokuk Elec. Co., J. P. Ingle, Mgr., will constr. addition to storage tanks to increase capy. double.

Ia., Odebolt—$15,000 bonds voted for extension of water works sys.

Kans., Dodge City—Permission to expend $27,000 for impvts. to water works system granted by Public Utilities Comn. New standpipe with capy. of 500,000 gals. will be erected with a portion of the funds. Numerous new cross mains to be installed.

Kans., Phillipsburg—$30,000 voted for improvement of city water system.

La., Ebenezer—City contemplates bldg. water works system. About $50,000.

Md., Baltimore—Brooklyn Center Co., 1025 Munsey Bldg., having plans prepared for laying 4,000 ft. 6 and 8-in. c. i. pipe in Brooklyn (city's new annex), to connect with city water system. About $8,000. J. S. Howard, 12 E. Lexington St., Engr.

Md., Garret—Dist. Commrs. Washington Suburban Sanitary Dist., will construct filtration plant on Rock creek; daily capy. 1,000,000 gals. R. B. Morse, Engr., Hyattsville, Md.

Mass., Chicopee—Appropriations passed final readings by Bd. of Aldermen amounting to $92,800 and other appropriations through first readings amounting to $18,857. Principal amt. was that of $66,000 for a standpipe on Keating Hill, 130 ft. high., capy. of 1,900,000 gals. of water.

Mass., Pittsfield—City plans to replace water mains in Pomery avenue with larger mains and water pipe extensions in Holmes Rd. and Parker tract. Est. cost $20,000; also water extensions to Swamp Rd., $5,000.

Mass., Worcester—City considering rebldg. and enlarging Tatnuck reservoir. About $200,000.

Mo., Boonville—City to install water mains. $35,000.

Mo., Caruthersville—City will reconstruct and extend water and electric light systems. Black & Veatch, Engrs., Interstate Bldg., Kansas City, Mo.

Mo., Fairfax—City will improve water and sewer systems. $40,000. Archer & Stevens, Engrs., 609 New England Bldg., Kansas City, Mo.

Mo., Maysville—$50,000 filtration plant will be built by city. E. E. Harper, Engr., 2408 E. 30th St., Kans. City; A. D. Hewitt, City Clk.

Mo. Mt. Vernon—Bd. of Mgrs. Missouri State Sanatorium, will constr. water system; 100,000 gal. steel tank on 75 ft. tower; deep well pump; steam exhaust pump discharge and supply lines. Plans from Hohenschild & Pearce, Odd Fellows Bldg., St. Louis.

Minn., Elk River—Sherburne Co. voted $38,000 bonds to build water works system. C. S. Wheaton, Aud.

Neb., Alliance—City voted $10,000 bonds to build extensions to water mains. C. Calder, Clk.

Neb., Lincoln—Plans being prepared by City Engr. Bates for reservoir, estimated to hold 2,000,000 gal. Approx. cost, $30,000.

N. M., Columbus—El Paso & Southwestern Ry. will construct steel water tank.

N. Y., Herkimer—City considering constr. of water system from Gravesville, Russia Twp., to city. C. L. Earl, Herkimer.

N. C., Franklinton—Town considering constr. of water supply system. $50,000 bonds voted.

N. C., Warsaw—City contemplates water works impvts.; 2½ miles 6, 8, 10-in. c. i. water mains, valves, specials, hydrants, tower and tank; 150 H. P. boiler; 2 well pumps. Wm. M. Piatt, Engr., Durham, N. C.

N. C., Zebulon—City considering water works impvts.; 4 miles 6 to 10-in. c. i. pipe; valves, hydrants, pupming stations, tower and tank, motor driven pumps, reservoirs, etc. Wm. M. Piatt, Engr., Durham, N. C.

N. D., Fargo—Resolution made to constr. water main in Water Main Dists. No. 1 and No. 2, in certain streets. A. R. Watkins, Aud. Cass Co.

N. D., Fargo—City Comn. at special meeting instructed Robert Jacobson, Acting City Engr., to prepare plans for water main on 7th avenue, S. bt. 14th and 15th streets.

O., Mansfield—District considering impvts. to water system which will cost about $83,670. Included are the following: 2 new wells, 3 triplex power pumps with suitable housing and 12-in. force main from wells extending to intersect. of Main and Giessner avenue—16,100 ft.

O., Port Clinton—People of Gypsum and Plasterbed—four miles east of here—will be furnished with a supply of water for domestic and mfg. purposes, from water plant at Port Clinton.

Okla., Carnegie—V. V. Long, Engr., Colcord Bldg., Okla. City, Engineer for water works extension for town. Mr. Robohn, City Clk.

Okla., Indiahoma—Town considering pumping equipt., 40-ft. steel tower and tank; mains and hydrants; $15,000. Mrs. C. C. Ennes, Secy.

O., Marion—Ords. passed authorizing Water Company t oxmdnteieasnPe yS Water Company to extend mains on Herman street, Mound street to Hocking Valley railroad and on Christian street and Uncapher avenue. Petitions for extension of mains on Henry street to Indiana avenue referred to water works committee.

Okla., Madill—Plans and specfs. for water works impvts. in progress. Bonds voted in amt. of $60,000. Johnson & Benham, Conslt. Engrs., Kans. City, Mo.

Okla., Tonkawa—Election to be called soon to vote on bonds. Approx. amt. of $117,000 for water works and light extensions. Johnson & Benham, Conslt. Engrs., Kans. City, Mo.

Okla., Tulsa—City considering constr. of water works system; water to be taken from Spavinaw creek. Total est. cost, $4,853,020. Plans include solid masonry, rein. conc. or wooden dams, 30, 35 and 50 ft. high and hydro-electric power house. $248,445, 42 in. c. i. rein. conc. or wooden stave pipe conduits, $2,900,405; three 20,000,000-gal. capy. reservoirs, $225,000; one 80,000,000-gal. capy. reservoir, $314,000; power plant, $225,000; pumping plant, $150,000; transmission lines, $360,000, etc., etc.

Pa., Red Lion—Red Lion Water Works Company has decided to drill 4 artesian wells at pumping station between Red Lion and Yoe on Old Taylor farm.

S. D., Lennox—City will hold special election to vote on issuance of bonds for sinking of mammoth new well for city water works system.

Va., Orange—City contemplates enlarging water works and increasing water supply.

Va., Portsmouth—City will extend water mains to West Haven as soon as rights of way can be secured.

Va., Berryville—Gannett, Seelye & Fleming, Engrs., 204 Locust St., Harrisburg, Pa., engineers for water system for town. Est. cost, $30,000.

Vt., Burlington—Town of Winooski may purchase and install high-pressure pump at its reservoir at cost not to exced $5,000. Resolution to this effect introduced by Comm.

BRIDGES AND BUILDINGS.

Ariz., Phoenix—State will construct a number of hwy. bridges this season. One will be built across Gila river near Clifton; another near San Carlos and a third 16 mi. east of Yuma. Legislature has appropriated $65,000 for approaches to San Carlos bridge which was erected by the Indian service.

Ark., Ozark—Franklin county will soon award contract for constr. of a $400,000 steel brdg. across the Arkansas river at Ozark.

Cal., Long Beach—Supvrs. Los Angeles Co., have agreed to construct 3 bridges across flood diversion channel in Long Beach; one at Ocean avenue, another at Seventh street and a third at Anaheim Rd.

Cal., Pasadena—Asst. City Engr. E. P. Dewey, preparing plans for a rein. conc. bridge across Arroyo Seco in southern part of city, making a direct route to San Rafael Heights. Bridge will cost about $60,000.

Cal., Woodland—Yolo County Bd. of Supvrs. have decided to construct 3 brdgs. one costing $30,000 to span Cache creek, no. of Capay; $20,000 bascule brdg. over Sycamore Slough near Knights Landing and $10,000 has been appropriated for Davis brdg. across Putah creek between Yolo and Solano Counties. Counties will share the cost.

Conn., Bristol—City plans to build 2 rein. conc. brdgs.; one on Main street and one on Laurel street. About $25,000. Sperry & Buell, Inc., 175 Main St., Engrs.

Ct., Hartford—Council voted in favor of closing contract with Berlin Iron Works to prepare plans for conc. work on Main street bridge over Pequabuck river. Report made by City Engr. C. W. Buell that the repairs, which will rebuild the bridge, will cost about $8,000.

Del., Wilmington—Plans under way for bldg. new bridge across the Brandywine at Washington street to take place of present structure. If possible work will start by September 1.

Ga., Savannah—Bridge will be built at Sisters Bluff at cost of between $100,000 and $125,000.

Ill., Amboy—Plans being considered for new bridge over Rock river at First avenue, in Sterling.

Ill., Cairo—County Board has decided to assist in repair of Cache bridge which is a very important crossing.

Ill., Danville—Town contemplates replacing Gilbert street bridge with modern rein. conc. structure, probably of arch type; length 1,140 ft., maximum height about 70 ft. Harlan H. Edwards, City Engr.

Ill., Kingston—Town considering repair of Holroyd bridge over Kishwaukee river where same is crossed by hwy. leading from Kingston to Belvidere. County aid applied for. Bridge may also be constructed over stream known as branch of the Somoauk creek where same is crossed by hwy. running north and south through Sect. 23, Clinton Twp.

Ind., Indianapolis—Bd. of Public Works considering constr. of bridge over Fall creek in North Delaware street. $110,000.

Ia., Des Moines—Plans nearing completion for Forest avenue bridge. Dana Thomas, City Engr.

Ia., Des Moines—Viaduct will be constr. which is an extension of University avenue bridge, at $82,000.

Ia., Muscatine—Bd. of Supvrs. Muscatine County and Johnson County considering constr. and repair on bridge which is on the border of the two counties west of West Liberty.

Kans., El Dorado—State Hwy. Comm. has approved 3 new concrete bridges across the Walnut river. Total est. cost, $75,000.

Me., Bangor—Wooden bridge over the Mattawamkeag river near Wytopitlock has been condemned by the state and will be replaced by concrete structure. Est. cost, $100,000. Work will be done under supervision of Sate Hwy. Dept.

Me., Biddeford—Fed. appropriation of $500,000 for bridge across the Piscataquis river between Portsmouth, N. H. and Kittery, Me., is contained in naval bill to be reported to the senate. $500,00 has already ben appropriated by State N. H.; Maine has appropriated $7,000,000 for roads and bridges, of which $500,000 will be used for this bridge.

Mass., Boston—Essex County Commrs. have been authorized to build bridge over Ipswich river at High street in Topsfield.

Minn., Hibbing—Nearly 60 bridges will be constructed in 7th District by County. Contracts for 8 of the structures, which are to be of steel and concrete, will soon be let. $335,000 will be expended for these bridges and work will take up entire summer as well as into the fall.

Mo., Poplar Bluff—Petition circulated in City, Butler and Dunklin Co., requesting the two county courts to have steel brdg. built across St. Francis river in southeast corner of county on road from Qulin to Campbell.

Mont., Helena—U. S. Bureau of Public Roads has approved plans prep. by Mont. Hwy. Comn. Engrs. for 3 Federal aid brdg. projects in state. Complete cost $270,000. Huntley brdg. over Yellowstone river east of here is largest of these bridges. Total cost, including brdg. approaches and protective work, $166,000;Toston brdg. over Missouri river, Broadwater Co., $65,000; rein. conc. brdg. at Carter, Park Co., 3 arched spans, about $40,000.

Mont., Butte—New steel bridge must be built across Big Hole river near Melrose, as present structure is considered unsafe. New brdg. will be constructed by Silver Bow and Beaverhead Cos. Est. cost, $28,000.

Mont., Hamilton—Ravilli Co. plans to constr. 280-ft. brdg. over Bitterroot river, 16 ft. wide, two 140-ft. spans. About $20,000.

N. C., Goldsboro—Wayne Co. plans to construct 175-ft. steel and conc. brdg., 16 ft. wide. Abt. $20,000. S. D. Scott, Goldsboro, Engr.

Neb., Lincoln—City Council authorizes constr. of rein. conc. brdg. across Oak creek channel on 14th street. Total est. cost, $16,000.

O., Jefferson—Lake County voters have carried proposition to build high level brdg. at Willoughby.

Tenn., Maynardsville—$10,000 bonds voted for constr. of brdg. over Clinch river, Union Co., at Longmire Ferry.

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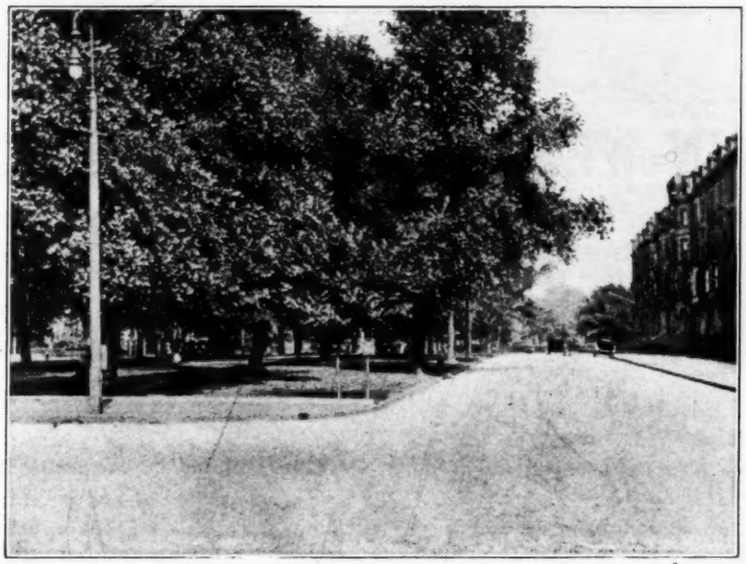

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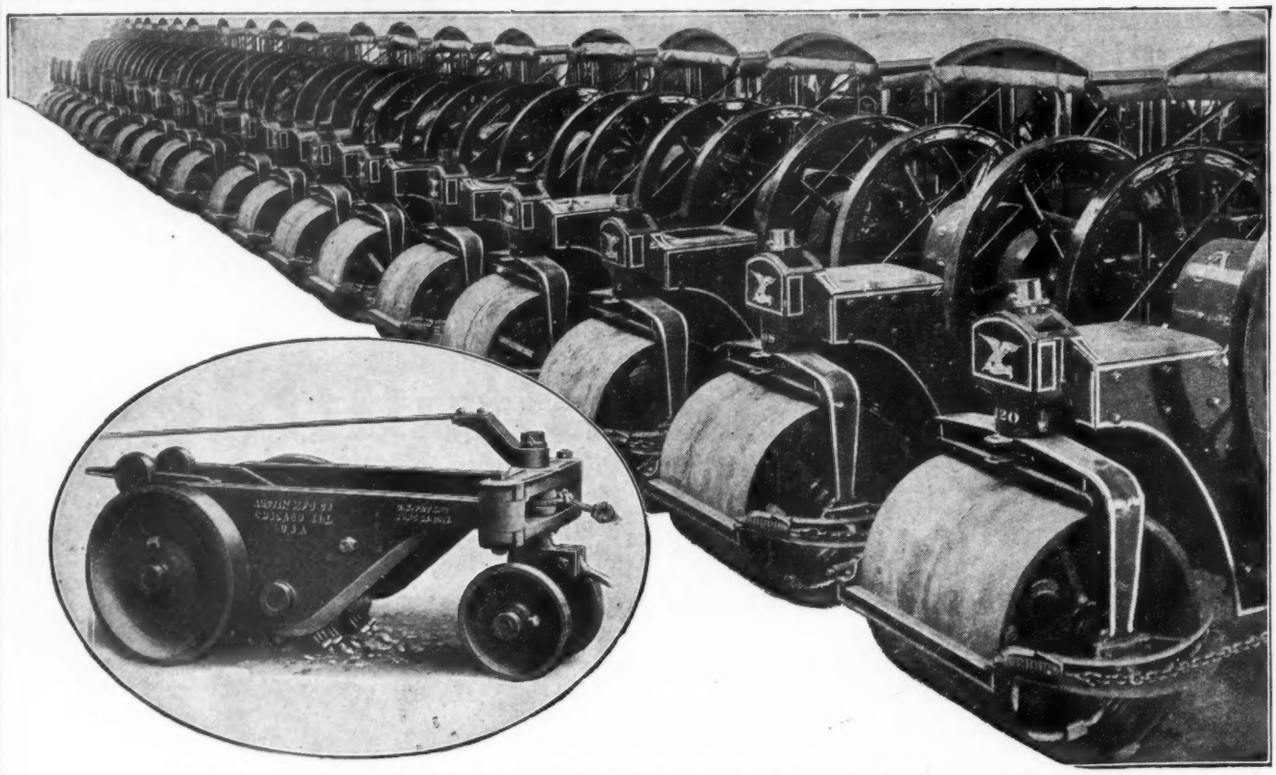

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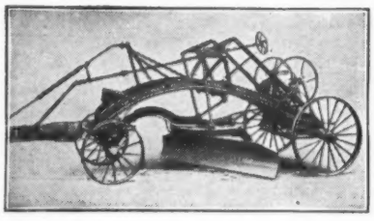

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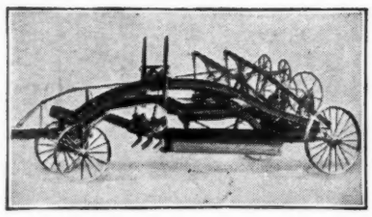

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